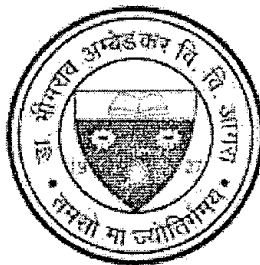# DR. BHIMRAO AMBEDKAR UNIVERSITY
AGRA (UTTAR PRADESH)

SYLLABUS
EXAMINATION PATTERN
RULES & REGULATIONS

for

STATISTICS
(Faculty of Science)

National Education Policy-2020
as per FYUP
(w.e.f. Session 2025-26)

Courses Offered

Bachelor of Science (B.Sc.)

Bachelor of Science (Honours) in Statistics

Bachelor of Science (Honours with Research) in Statistics

Apprenticeship/Internship Embedded UG Degree in Statistics

Master of Science (M.Sc. in Statistics)

National Education Policy-2020
Common Minimum Syllabus for all U.P. State Universities/ Colleges
SUBJECT: STATISTICS

Name	Designation	Affiliation
Steering Committee		
Mrs. Monika S. Garg, (I.A.S.)Chairperson Steering Committee	Additional Chief Secretary	Dept. of Higher Education U.P., Lucknow
Prof. Poonam Tandan	Professor, Dept. of Physics	Lucknow University, U.P.
Prof. Hare Krishna	Professor, Dept. of Statistics	CCS University Meerut, U.P.
Dr. Dinesh C. Sharma	Associate Professor, Dept. of Zoology	K.M. Govt. Girls P.G. College Badalpur, G.B. Nagar, U.P.
Supervisory Committee-Science Faculty		
Dr. Vijay Kumar Singh	Associate Professor, Dept. of Zoology	Agra College, Agra
Dr. Santosh Singh	Dean, Dept. of Agriculture	Mahatma Gandhi Kashi Vidhyapeeth, Varanasi
Dr. Baby Tabussam	Associate Professor, Dept. of Zoology	Govt. Raza P.G. College Rampur, U.P.
Dr. Sanjay Jain	Associate Professor, Dept. of Statistics	St. John's College, Agra

Syllabus Developed by:

S.No.	Name	Designation	Department	College/University
1.	Prof. Sunil Kumar Pandey	Retd. Professor	Statistics	Lucknow University, Lucknow
2.	Dr. Rajiv Saksena	Analyst cum Programmer	Statistics	Lucknow University, Lucknow
3.	Mr. Digvijay Pal Singh	Associate Professor	Statistics	Agra College, Agra

Syllabus Restructured/Developed as per FYUP (w.e.f. 2025-26) for Dr. Bhim Rao Ambedkar University, Agra by:

S.No.	Name	Designation	College/University
1.	Prof. Sanjay Jain	Convenor, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	St. John's College, Agra
2.	Prof. Namita Srivastava	Member, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	St. John's College, Agra
3.	Prof. Sunil Kumar	Member, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	RBS College, Agra
4.	Prof. Uma Rani	Member, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	BSA College, Mathura
5.	Mr. Digvijay Pal Singh	Member, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	Agra College, Agra
6.	Dr. Alok Kumar Singh	Member, Board of Studies (Statistics), Dr. B.R. Ambedkar University, Agra	RBS College, Agra

UNDER GRADUATE PROGRAM
(First Six Semesters)

Eligibility for Admission in B.Sc. First Year (First Semester):
A candidate who has passed 12th Standard with **Mathematics** as one of the subject from Madhyamic Shiksha Parishad, Uttar Pradesh or any Indian University duly incorporated by any Law enforce for the time being or any other examination recogniosed by the University as equivalent there to shall be permitted to take admission in B.Sc. First Semester with Statistics as one of his/her subject.

Attendance:
Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Assessment Pattern:
In **theory papers** the assessment of the student shall be divided into two parts in which first part is continuous internal assessment (25 marks) and second part is semester assessment or external assessment or end-term assessment (75 marks).
In **practical papers and research project** the assessment of the student shall be based on semester assessment or external assessment or end-term assessment (100 marks).
There will be no continuous internal assessment in case of papers of Practical and Research Project.

Continuous or Internal or Mid Term Assessment:
The continuous or internal or mid-term assessment (25 marks) for each theory paper shall be taken by the faculty members in the Department during each semester.

Semester or External or End Term Assessment:
I.   The semester or external or end-term assessment of each theory paper (75 marks) shall be of three hours duration and same of each practical paper and research project (100 marks) shall be of three hours duration taken by the University at the end of each semester.
II. The syllabus for each theory paper is divided into independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A will carry 20 maks. There will be 10 compulsory very short answer type questiosn Each question shall be of two marks.
Section-B will carry 25 marks. There will be 08 short answer type questions (answer in minimum 50 words) out of which students has to attempt any 05. Each question shall be of five marks.
Section-C will carry 30 marks. There will be 04 long answer type questions (answer in minimum 300 words) out of which students has to attempt any 02. Each question shall be of fifteen marks.

**Paper setter shall be advised to design question paper covering from all units.**

External or End Term Practical Examination Evaluation Methods: (100 Marks)
Practical Examination Evaluation shall be based on Viva-voce and Practical Exercises. The marks shall be as follows:

Practical Exercise (Major%) 01 x 30 Marks	**30 Marks**
Practical Exercise (Minor%) 02 x 20 Marks	**40 Marks**
Viva-voce and Practcial Record	**30 Marks**

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

Or
Examination pattern as decided by Examination Committee of the University
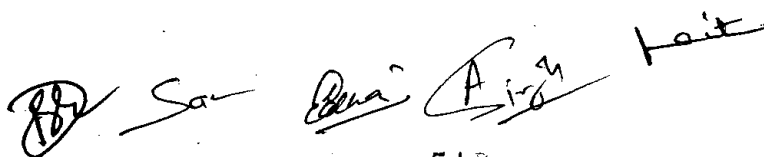## or
any other Regulatory Body
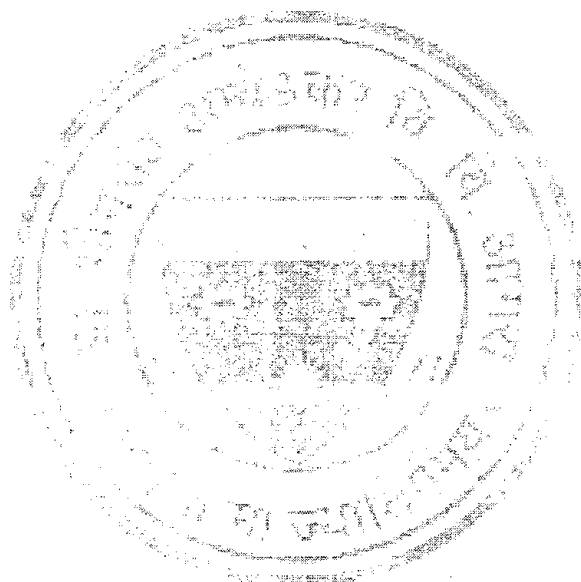
PAPER CODING AND CREDIT DISTRIBUTION
B.Sc. (Statistics)

Year	Sem.	Course Code	Paper Title	Theory/Practical	Credits
I	I	B060101T	Descriptive Statistics (Univariate) and Theory of Probability	Theory	04
		B060102P	Descriptive Data Analysis Lab (Univariate)	Practical	02
	II	B060201T	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	04
		B060202P	Descriptive Data Analysis Lab (Bivariate)	Practical	02
II	III	B060301T	Theory of Estimation and Sampling Survey	Theory	04
		B060302P	Sampling Survey Lab	Practical	02
	IV	B060401T	Testing of Hypothesis and Applied Statistics	Theory	04
		B060402P	Test of Significance and Applied Statistics Lab	Practical	02
		B060403R	Research Project	Research	03
III	V	B060501T	Multivariate Analysis and Non-parametric Methods	Theory	04
		B060502T	Analysis of Variance and Design of Experiment	Theory	04
		B060503P	Non-paramertic Methods and DOE Lab	Practical	02
	VI	B060601T	Statistical Computing and Introduction to Statistical Software	Theory	04
		B060602T	Operations Research	Theory	04
		B060603P	Operations Research and Statisical Computing Lab	Practical	02

:: Subject Prerequisties::

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

:: Programme Outcomes (POs) ::

Students having Degree in B.Sc. (with Statistics) should have knowledge of different concepts and fundamentals of Statistics and ability to apply this knowledge in various fields of industry. They may pursue their future career in the field of Statistics and Research.

:: Programme Specific Outcomes (PSOs) ::

After completing B.Sc. (with Statistics) the student should have
- ➤ Knowledge of different concepts, principles, methodologies and tools (skills) of Statistics.
- ➤ Ability to collect, tabulate, represent graphically, analyze and interpret data/information by using appropriate statistical tools.
- ➤ Ability to identify and solve a wide range of problems in real life/industry related to Statistics.
- ➤ Familiarity with computational techniques and statistical software including programming language (e.g. R) for mathematical and statistical computation.
- ➤ Capability to use appropriate statistical skills in interdisciplinary areas such as finance, health, agriculture, government, business, industry, telecommunication and bio-statistics.
- ➤ Ability to compete with industrial/private sector demand in the field of data analysis, marketing survey, etc. in professional manner and pursue their future career in the field of Statistics.
- ➤ Ability to develop original thinking for formulating new problems and providing their solutions. As a result, they will be able to pursue higher studies or research in the field of Statistics.

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

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

Programme	Year	Semester	Course Title		Credits	Teaching Hours
Diploma in Mathematical & Applied Statistics with Statistical Inference	II	Third	Theory(B060301T) Theory of Estimation and Sampling Survey	Part-A: Sampling Distributions and Theory of Estimation	04	60
				Part-B: Sampling Survey		
			Practical(B060302P): Sampling Survey Lab		02	60
		Fourth	Theory(B060401T) Testing of Hypothesis and Applied Statistics	Part-A: Testing of Hypothesis and Tests of Significance	04	60
				Part-B: Applied Statistics		
			Practical(B060402P): Test of Significance and Applied Statistics Lab		02	60
			Research Project (B060403R)		03	90

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

Programme/Class: **Certificate**	Year: **First**	Semester: **First**

Subject: **STATISTICS**

Course Code: -**B060101T**	Course Title: **Descriptive Statistics (Univariate) and Theory of Probability**

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

Credits: 04	Core: Compulsory
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **33 with minimum 25 in End Exam**

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

Unit	Topic	No. of Lectures
	Part-A: Descriptive Statistics (Univariate)	
I	Introduction and contribution of Indian Scholars in Statistics. Contribuion of Prof. PC Mahalanobis, Prof. CR Rao, Prof. VS Huzurbazar etc. History and Evolution of Statistical System in India. Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data.	06
II	Presentation of data : Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Box Plot.	08
III	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures.	10

● IV	Moments and Factorial moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures based on quartiles.		06
Part-B: Theory of Proability			
V	Random experiment, Trial, Sample point and Sample space, Events, Operations of events, Concept of equally likely, Mutually exclusive and Exhaustive events. Definition of Probability: Classical, Relative frequency and Axiomatic approaches.		04
VI	Discrete Probability Space, Properties of Probability under Set Theory Approach, Independence of Events, Conditional Probability, Total and Compound Probability theorems, Bayes theorem and its Applications.		09
VII	Random Variables – Discrete and Continuous, Probability Mass Function (pmf) and Probability density function (pdf), Cumulative distribution function (cdf). Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables.		08
VII	Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables, Conditional expectation and related problems. Moments, Moment generating function (m.g.f.) & their properties, Continuity theorem for m.g.f. (without proof). Chebyshev's inequality, Weak law of large numbers for a sequence of independently and identically distributed random variables and their applications. (Statement Only)		09

Suggested Readings:

Part A:

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

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

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

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

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

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

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

Part B:

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

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

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

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

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

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

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

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

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

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

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

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

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

Books in Hindi Language may be included by the Universities.

Suggested Online Links/Readings:

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

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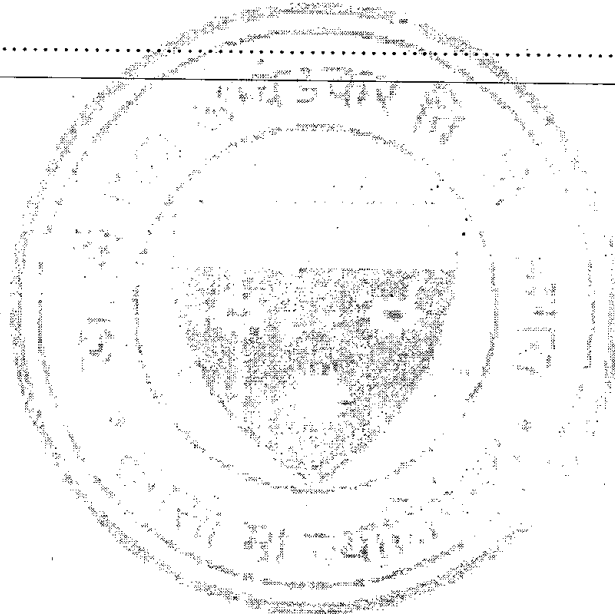**Open to ALL**

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

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

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

Suggested equivalent online courses:
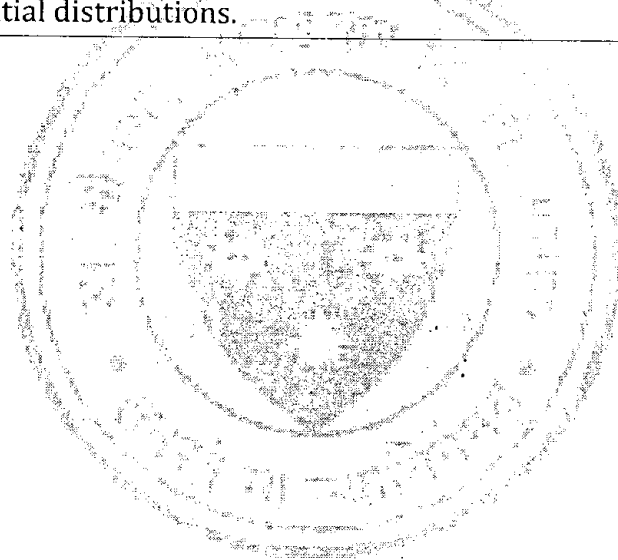..

Further Suggestions:
....

Programme/Class: **Certificate**	Year: **First**	Semester: **First**
Subject: STATISTICS		
Course Code: -**B060102P**	Course Title: **Descriptive Data Analysis Lab (Univariate)**	

Course outcomes:

After completing this course a student will have:

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

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

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

✓ Ability to measure skewness and kurtosis of data and define their significance.

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

Credits: **02**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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 B060101T.

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

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

Suggested equivalent online courses:
....

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

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**

Subject: **STATISTICS**		

Course Code: -**B060201T**	Course Title: **Descriptive Statistics (Bivariate) and Probabiity Distributions**

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the method of least squares for curve fitting to theoretically describe experimental data with a function or equation and to find the parameters associated with the model.
- ✓ Knowledge of the concepts of correlation and simple linear regression and Perform correlation and regression analysis.
- ✓ Ability to interpret results from correlation and regression.
- ✓ Ability to compute and interpret rank correlation. .
- ✓ Ability to understand concept of qualitative data and its analysis.
- ✓ Knowledge of discrete distributions. Discuss appropriate distribution negative binomial, Poisson, etc. with their properties and application of discrete distribution models to solve problems.
- ✓ Knowledge of continuous distributions. Discuss the appropriate distribution (i.e. uniform, exponential, normal, etc.) with their properties and application of continuous distribution models to solve problems.
- ✓ Knowledge of the formal definition of order statistics, derive the distribution function and probability density function of the rth order statistic and joint distribution of rth and s^{th} order statistics.
- ✓ Ability to identify the application of theory of order statistics in real life problems.

Credits: 04			Core: **Compulsory**

Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **33 with minimum 25 in End Exam**

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

Unit	Topic	No. of Lectures
Part-A: Descriptive Statistics (Bivariate)		
I	Bivariate data, Principles of least squares, Most plausible values, Meaning of curve fitting, Fitting of straight line, parabola, logarithmic, power curves and other simple forms by method of least squares.	08
II	Bi-Variate frequency table, Correlation, Types of relationships, Scatter diagram, Karl-Pearson's Correlation Coefficient and its properties.	08
III	Rank correlation and its coefficient (Spearman and Kendall Measures) Regression analysis through both types of regression equations for X and Y variables.	08
IV	Attributes: Notion and Terminology, Contingency table, Class frequencies and Ultimate class frequencies, Consistency, Association of Attributes, Independence, Measures of association for 2X2 table, Chi-square, Karl Pearson's and Tschuprow's Coefficient of Association.	06

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

Suggested Readings:

Part A:

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

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

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

Part B:

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

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

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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.

Books in Hindi Language may be included by the Universities.

Suggested Online Links/Readings:

http://heecontent.upsdc.gov.in/SearchContent.aspx
https://swayam.gov.in/explorer?searchText=statistics
https://nptel.ac.in/course.html

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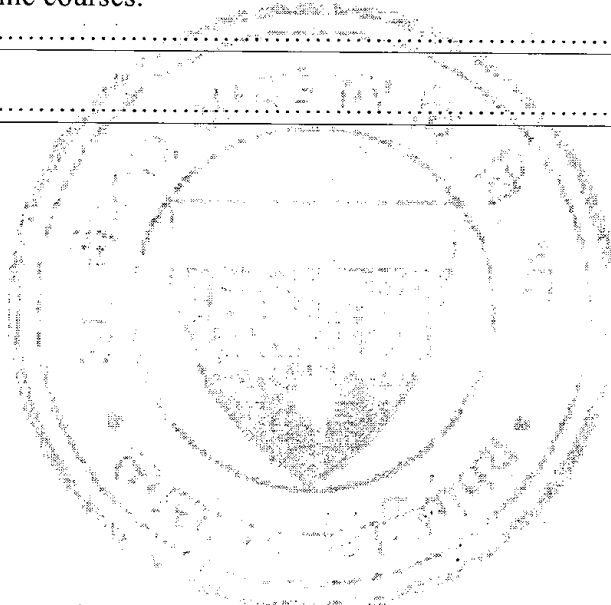**Open to ALL**

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

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

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

Suggested equivalent online courses:
....

Further Suggestions:
....

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**

Subject: **STATISTICS**		
Course Code: -**B060202P**	Course Title: **Descriptive Data Analysis Lab (Bivariate)**	

Course outcomes:
After completing this course a student will have:
1. Ability to deal with the problems based on fitting of curves by Method of least squares e.g. fitting of straight line, second degree polynomial, power curve, exponential curve etc.
2. Ability to deal with problems based on determination of Regression lines and calculation of Correlation coefficient – grouped and ungrouped data.
3. Ability to deal with the problems based on determination of Rank correlation.
4. Ability to fit binomial and poisson distribution for given data..

Credits: **02**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

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

Suggested Readings:
As suggested for paper code B060201T.

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

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

Suggested equivalent online courses:
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Further Suggestions:
In practical classes a series of lectures for any statistical software (e.g. SPSS) may be organized for students and they may be asked to use it to perform practical problems assigned to them.

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

Course outcomes:

After completing this course a student will have:

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

Credits: 04		Core: **Compulsory**
Max. Marks: **25 (CIE) + 75 (End Exam)**		Min. Marks: **33 with minimum 25 in End Exam**
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Unit	Topic	No. of Lectures
Part-A: Sampling Distributions and Theory of Estimation		
I	Sampling Distributions: The concept of sampling distribution, Parameter, Statistic and Standard error. The sampling distribution for the sum of independent random variables of Binomial, Poisson and Normal distribution.	04
II	Central limit theorem, sampling distribution of Z. Sampling distribution of t, f, and chi-square without derivations, Simple properties of these distributions and their interrelationship.	09
III	Point estimation: Characteristics of a good estimator: Unbiasedness, consistency, sufficiency and efficiency, completeness.	08
IV	Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of minimum Chi-square. Method of least squares and methods of moments for estimation of parameters	09

		Part-B: Sampling Survey	
V		Sampling vs. Complete enumeration: Sampling units and Sampling frame, Precision and efficiency of estimators, Simple Random sampling with and without replacement, Use of random number tables in selection of simple random sample, Estimation of population mean and proportion, Derivation of expression for variance of these estimators, Estimation of variances, Sample size determination, Sampling vs Non-sampling errors	08
VI		Stratified random sampling, Problem of allocation, proportional allocation, optimum allocation. Derivation of the expressions for the standard error of the usual estimators when these allocations are used, Gain in precision due to Stratification, Role of sampling cost in the sample allocation, Minimization of variance for fixed cost.	08
VII		Systematic Sampling: Estimation of Population mean and Population total, standard errors of these estimators Two stage sampling with equal first stage units: Estimation of Population mean and its variance	08
VIII		Regression and ratio methods of estimation in simple random sampling, Cluster sampling with equal clusters, Estimators of population mean and their mean square errors.	06

Suggested Readings:

Part-A

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Part-B

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

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

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

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

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

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

Mukhopadyay, P. (2007). Survey Sampling. Narosa Publisher, New Delhi.

Murthy, M. N. (1977). Sampling Theory and Statistical Methods. Statistical Pub. Society, Kolkata.

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

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

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

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

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

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

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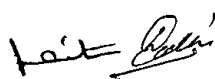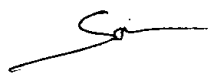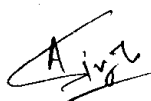The marks shall be as follows:

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

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

Suggested equivalent online courses:
....

Further Suggestions:
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Programme/Class: **Diploma**	Year: **Second**	Semester: **Third**

Subject: **STATISTICS**

Course Code: -**B060302P**	Course Title: **Sampling Techniques Lab**

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

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

Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

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

Suggested Readings:
As suggested for paper code B060301T.

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

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

Suggested equivalent online courses:
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Further Suggestions:
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.

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		

Course Code: -**B060401T**	Course Title: **Testing of Hypothesis and Applied Statistics**

Course outcomes:

After completing this course a student will have:

- ✓ Knowledge of the terms like null and alternative hypotheses, two-tailed and one-tailed alternative hypotheses, significant and insignificant, level of significance and confidence, p value etc.
- ✓ Ability to understand the concept of MP, UMP and UMPU tests
- ✓ Ability to understand under what situations one would conduct the small sample and large sample tests (in case of one sample and two sample tests).
- ✓ Familiarity with different aspects of Applied Statistics and their use in real life situations.
- ✓ Ability to understand the concept of Time series along with its different components.
- ✓ Knowledge of Index numbers and their applications along with different types of Index numbers.
- ✓ Familiarity with various demographic methods and different measures of mortality and fertility.
- ✓ Ability to understand the concept of life table and its construction.
- ✓ Knowledge to understand the concept of statistical quality control and different control charts for variables and attributes.

Credits: 04	Core: **Compulsory**
Max. Marks: 25 (CIE) + 75 (End Exam)	Min. Marks: **33 with minimum 25 in End Exam**

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

Unit	Topic	No. of Lectures
Part-A: Testing of Hypothesis and Tests of Significance		
I	Statistical Hypothesis (Simple and Composite), Testing of hypothesis. Type –I and Type – II errors, Significance level, p-values	08
II	Power of a test, Definitions of Most Powerful (MP), NP Lemma. Uniformly Most Powerful (UMP) and Uniformly Most Powerful Unbiased (UMPU) tests	08
III	Test of significance: Large sample tests for (Attributes and Variables) proportions and means (i) for one sample (ii) for two samples Correlation coefficient in case of (a) $p=p_0$ (b) $p_1=p_2$,	10
IV	Small sample test based on t, f and chi-square distributions.	04

		Part-B: Applied Statistics	
V		Introduction & Definition of Time Series, its different components, illustrations, additive and multiplicative models. Determination of trend by free hand curve, semi average method, moving average method, method of least squares, Analysis of Seasonal Component by Simple average method, Ratio to moving Average Ratio to Trend, Link relative method.	09
VI		Index number – its definition, application of index number, price relative and quantity or volume relatives, link and chain relative, problem involved in computation of index number, use of averages, simple aggregative and weighted average method. Laspeyre's, Paasche's and Fisher's index number, time and factor reversal tests of index numbers, consumer price index.	09
VII		Vital Statistics: Measurement of Fertility– Crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate, standardized death rates Complete life table, its main features and construction.	06
VII		Introduction to Statistical Quality Control, Process control, tools of statistical quality control, $\pm 3\sigma$ control limits, Principle underlying the construction of control charts. Control charts for variables, 'X' and 'R' charts, construction and interpretation, Control charts for attributes 'p' and 'c' charts, construction and interpretation	06

Suggested Readings:
Part A

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

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

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

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

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

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

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

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

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

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

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

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

Part B

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

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

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

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

Books in Hindi Language may be included by the Universities.

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

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

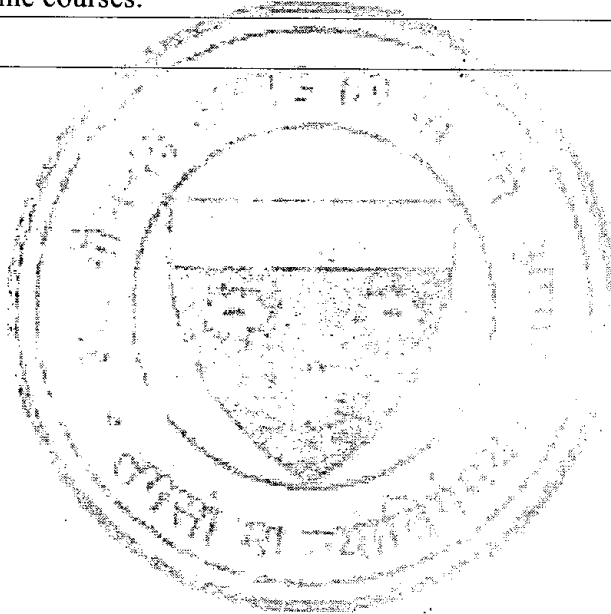**Suggested Continuous Evaluation Methods:**
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests.
The marks shall be as follows:

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

Course prerequisites: To study this course, a student must have opted/passed the **paper code B060301T.**
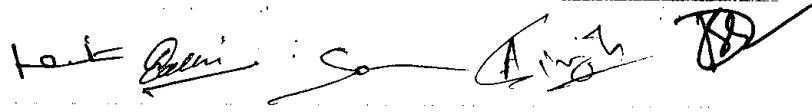
Suggested equivalent online courses:
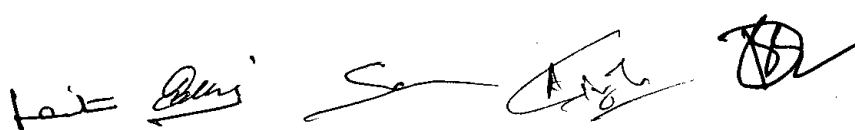
Further Suggestions:

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

Course outcomes:

After completing this course a student will have:

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

Credits: **02**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

	Topic	No. of Lectures
	1. Problems based on t – test. 2. Problems based on F-test. 3. Problems based on Chi-square test. 4. Problems based on Fisher's Z-transformation and its use in testing 5. Problems based on calculation of power curve. 6. Problems based on large sample tests. 7. Problems based on time series and its different components 8. Problems based on Index number. 9. Problems based on measurement of mortality and fertility. 10. Problems based on logistic curve fitting. 11. Problems based on life table. 12. Problems based on control charts for variables and attributes.	60

Suggested Readings:
As suggested for paper code B060401T.

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

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

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

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: -**B060403R**	Course Title: **Research Project**	

Course outcomes:

After completing this course a student will have:
1. Ability to handle with real life problems in Statistics
2. Ability to prepare a project report
3. Acquire knowledge about practical implementation of various statistical techniques

Credits: **03**	Core: **Elective**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

	Suggestive Topics/Thrust Areas	No. of Lectures
	1. Descriptive Statistics 2. Probability Distributions 3. Statistical Inference 4. Applied Statistics 5. Survey Report	90

Suggested Readings:

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This course can be opted as an elective by the students of following subjects:
Studying Statistics as one of the Major Subjects

Course prerequisites:

Suggested equivalent online courses:

....

Further Suggestions:

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

Subject: **STATISTICS**		

Course Code:-**B060501T**	Course Title: **Multivariate Analysis and Non-parametric Methods**

Course outcomes:

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

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

Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **33** with **minimum 25 in End Exam**

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

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

Suggested Readings:

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

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

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

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

Mukhopadhyay, P.: Mathematical Statistics.

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

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

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

Books in Hindi Language may be included by the Universities.

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

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

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

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

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

Suggested equivalent online courses:
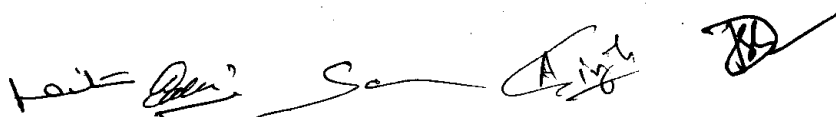..

Further Suggestions:
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Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Fifth**

Subject: **STATISTICS**		
Course Code: **-B060502T**	Course Title: **Analysis of Variance and Design of Experiment**	

Course outcomes:

After completing this course a student will have:

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

Credits: **04**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

Unit	Topic	No. of Lectures
I	Defintion of Analysis of Variance, Assumptions and Limitations of ANOVA, One way classification.	08
II	Two way classification with equal number of observations per cell. Duncan's multiple comparison tests.	07
III	Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials. Completely Randomised Design (CRD)	08
IV	Randomized Block Design (RBD), Concept and definition of efficiency of design; Comparison of efficiency between CRD and RBD.	07
V	Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD	08
VI	Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations.	07
VII	Factorial Experiments: General description of factorial experiments, 2^2, 2^3 and 2^n factorial experiments arranged in RBD and LSD, Definition of Main effects and Interactions in 2^2 and 2^3 factorial experiments,	08
VIII	Preparation of ANOVA by Yates procedure, Estimates and tests for main and interaction effects (Analysis without confounding).	07

Suggested Readings:

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

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

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

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

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

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

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

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

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

Books in Hindi Language may be included by the Universities.

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

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

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

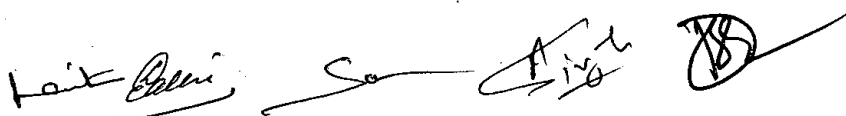| Assessment and Presentation of Assignment	(05 marks)
Class Test-I (Objective Questions)	(04 marks)
Class Test-II (Descriptive Questions)	(04 marks)
Class Test-III (Objective Questions)	(04 marks)
Class Test-IV (Descriptive Questions)	(04 marks)
Class Interaction	(04 marks)

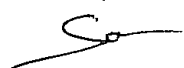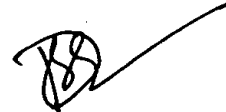| Course prerequisites: To study this course, a student must have opted/passed the Mathematics/Elementary Mathematics in Class 12th. |
|---|
| Suggested equivalent online courses: |
| Further Suggestions: |

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

Subject: **STATISTICS**		

Course Code: -**B060503P**	Course Title: **Non-parametric Methods and DOE Lab**

Course outcomes:

After completing this course a student will have:

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

Credits: **02**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

	Topic	No. of Lectures
	1. Problems based on Non-parametric tests for one sample. 2. Problems based on Non-parametric tests for two samples. 3. Problems based on Rank and Inverse of a matrix. 4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution. 5. Problems based on Principal Component Analysis 6. Problems based on Factor Analysis. 7. Problems based on Analysis of variance in one-way and two-way classification (with and without interaction terms). 8. Problems based on Analysis of a Latin square design. 9. Problems based on Analysis of variance in RBD and LSD with one or two missing observations. 10. Problems based on Factorial Experiment Practical.	60

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

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

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

Suggested equivalent online courses:
....

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

Programme/Class: **B.Sc.**	Year: **Third**	Semester: **Sixth**
Subject: STATISTICS		

Course Code: -**B060601T**	Course Title: **Statistical Computing and Introduction to Statistical Software**

Course outcomes:

After completing this course a student will have:

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

✓ Ability to perform data analysis for both univariate and multivariate data sets using R as well as SPSS

Credits: 04	Core: **Compulsory**
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **33 with minimum 25 in End Exam**

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

Unit	Topic	No. of Lectures
I	Introduction to Computer: Generation of Computer, Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for sImple statistical problems.	08
II	Introduction to R Programming and R Studio, Installing R, R as a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists	08
III	Data inputs: Entering data from the keyboard, Importing Data from Excel, SPSS. SAS, STATA, creating new variables, recoding variable, renaming variables, sorting data, merging	07
IV	Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.	08
V	Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kruskal Wallis test, Analysis of Variance (One-way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression	07
VI	SPSS Environment, entering data, Importing and Exporting data, Data Preparation, Data Transformation. Descriptive Statistics, Explore, Graphs using SPSS	08
VII	Graphs using SPSS, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.	07
VIII	Using SPSS: Non-parametric tests, Analysis of Variance (One-way & Two way Anova), Karl Pearson correlation coefficient, Linear Regression : Simple and Multiple regression	07

Suggested Readings:

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

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

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

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

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

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

Books in Hindi Language may be included by the Universities.

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

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

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

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

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

Suggested equivalent online courses:
....

Further Suggestions:
....

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

Subject: **STATISTICS**		
Course Code: -**B060602T**	Course Title: **Operations Research**	

Course outcomes:

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

Credits: **04**	Core: **Compulsory**
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **33** with **minimum 25 in End Exam**

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

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

Suggested Readings:

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

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

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

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

Books in Hindi Language may be included by the Universities.

Suggested Online Links/Readings:

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

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

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

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

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

Suggested equivalent online courses:
....

Further Suggestions:
....

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

Subject: **STATISTICS**		
Course Code: -**B060603P**	Course Title: **Operations Research and Statistical Computing Lab**	

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

Credits: **02**	Core: **Compulsory**
Max. Marks: **100 (End Exam)**	Min. Marks: **33 in End Exam**

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

Topic	No. of Lectures
1. Problem based on Mathematical formulation of L.P.P 2. Problem based on solving LPP using Graphical Method 3. Problem based on solving LPP using Simplex Method 4. Problem based on solving LPP using Charne's Big M method involving artificial variables. 5. Allocation Problem based on Transportation model. 6. Allocation Problem based on Assignment model. 7. Problems based on Game payoff matrix. 8. Problem based on solving Graphical solution to mx2/ 2xn rectangular game. 9. Problem based on solving Mixed strategy game. 10. Problem based on solving game using LPP method. 11. Problem based on application of R as Calculator. 12. Problem based on application of R in simple data analysis 13. Problem based on application of SPSS in data analysis	60

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

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

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

Suggested equivalent online courses:
....

Further Suggestions:
....

FYUP / P.G. PROGRAM

Eligibility for Admission in B.Sc. (Honours) in Statistics, B.Sc. (Honours with Research) in Statstics and M.Sc. (Statistics)

(1) A candidate who have passed B.Sc. with Statistics as a major subject from any University recognized by the UGC and secured atleast 75% marks in B.Sc. (for SC/ST category a relaxation of 5%) shall be permitted to take admission in **B.Sc. (Honours with Research).**

(2) A candidate who have passed B.Sc. with Statistics with Statistics as a major subject from any University recognized by the UGC and secured atleast 45% marks in B.Sc. (for SC/ST category a relaxation of 5%) shall be permitted to take admission in **B.Sc. (Honours).**

(3) A candidate who have passed **B.Sc. (Honours)** or **B.Sc. (Honours with Research)** in B.Sc. with Statistics as a major subject from any University recognized by the UGC and secured atleast 45% marks.(for SC/ST category a relaxation of 5%) shall be permitted to take admission in **One year M.Sc. (Statistics).**

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Assessment Pattern:

In **theory papers** the assessment of the student shall be divided into two parts in which first part is continuous internal assessment (25 marks) and second part is semester assessment or external assessment or end-term assessment (75 marks).

In **practical papers and research project** the assessment of the student shall be based on semester assessment or external assessment or end-term assessment (100 marks).

There will be no Internal assessment in case of papers of Practical and Research Project.

Continuous or Internal or Mid Term Assessment:

The continuous or internal or mid-term assessment (25 marks) for each theory paper shall be taken by the faculty members in the Department during each semester.

Semester or External or End Term Assessment:

I. The semester or external or end-term assessment (75 marks) shall be three hours duration to each theory paper and three hours duration for each practical paper and research project (100 marks) shall be taken by the University at the end of each semester.

II. The syllabus for each theory paper is divided into independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A will carry 20 maks. There will be 10 compulsory very short answer type questiosn Each question shall be of two marks.

Section-B will carry 25 marks. There will be 08 short answer type questions (answer in minimum 50 words) out of which students has to attempt **any 05**. Each question shall be of five marks.

Section-C will carry 30 marks. There will be 04 long answer type questions (answer in minimum 300 words) out of which students has to attempt **any 02**. Each question shall be of fifteen marks.

Paper setter shall be advised to design question paper covering from all units.

External or End Term Practical Examination Evaluation Methods: (100 Marks)

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

Paper setter shall be advised to design question paper covering from all units.

External or End Term Practical Examination Evaluation Methods: (75 Marks)

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

Practical Exercise 03 x 25 Marks%	75 Marks
Viva-voce	25 Marks

% There shall be 05-06 Practical Exercises in Examination (Students have to attend any 03).

Or
Examination pattern as decided by Examination Committee of the University
or
any other Regulatory Body
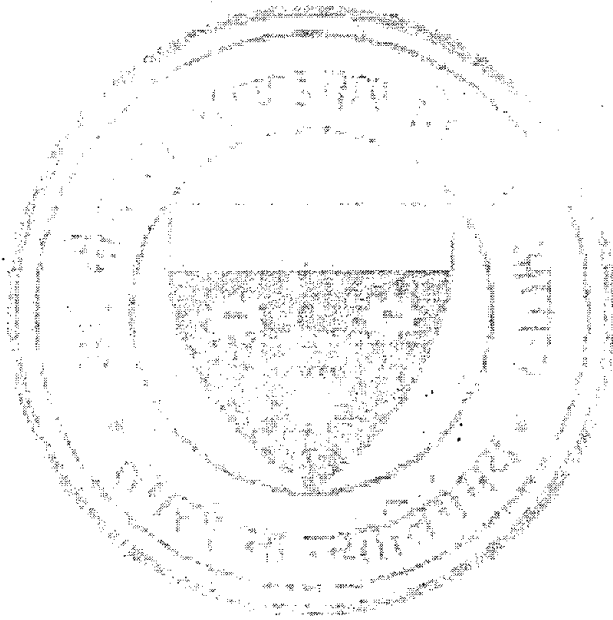
PAPER CODING AND CREDIT DISTRIBUTION FOR
B.Sc. (HONOURS) in STATISTICS

S.No.	Name of Degree	SEMESTER	TITLE OF PAPER	CREDITS	CODE NUMBER
1	Bachelor of Science (Honours) in Statistics	VII	Real Analysis & Matrix Algebra	4	B060701T
			Probability and Distribution Theory	4	B060702T
			Sampling Theory	4	B060703T
			Computer Science	4	B060704T
			Practical	4	B060705P
2		VIII	Statistical Inference-I	4	B060801T
			Linear Estimation and Design of Experiments	4	B060802T
			Multivariate Analysis	4	B060803T
			Elective-I (Choose any ONE paper) B060804T/ B060805T / B060806T		
			Data Analysis Using SPSS	4	B060804T
			Data Analysis Using R	4	B060805T
			Data Analysis Using Python	4	B060806T
			Practical	4	B060807P

PAPER CODING AND CREDIT DISTRIBUTION
B.Sc. (HONOURS WITH RESEARCH) in STATISTICS

S.No.	Name of Degree	SEMESTER	TITLE OF PAPER	CREDITS	CODE NUMBER
1	Bachelor of Science (Honours with Research) in Statistics	VII	Choose any THREE papers (B060701T/ B060702T / B060703T/B060704T)		
			Real Analysis & Matrix Algebra	4	B060701T
			Probability and Distribution Theory	4	B060702T
			Sampling Theory	4	B060703T
			Computer Science	4	B060704T
			Practical	4	B060705P
			Research Project Work		
2		VIII	Choose any TWO papers (B060801T/ B060802T / B060803T)		
			Statistical Inference-I	4	B060801T
			Linear Estimation and Design of Experiments	4	B060802T
			Multivariate Analysis	4	B060803T
			Elective-I (Choose any ONE paper) B060804T/ B060805T / B060806T		
			Data Analysis Using SPSS	4	B060804T
			Data Analysis Using R	4	B060805T
			Data Analysis Using Python	4	B060806T
			Practical	4	B060807P
			Research Project Work	8	B060808R

PAPER CODING AND CREDIT DISTRIBUTION
M.Sc. (STATISTICS)

3	Master of Science in Statistics	IX	Statistical Inference-II	4	B060901T
			Operations Research	4	B060902T
			Elective-II (Choose any ONE paper) B060903T/ B060904T/ B060905T/ B060906T/ B060907T/ B060908T		
			Data Mining	4	B060903T
			Population Studies	4	B060904T
			Medical Statistics	4	B060905T
			Official Statistics	4	B060906T
			Econometrics	4	B060907T
			Actuarial Statistics	4	B060908T
			Practical	4	B060909P
			Research Project Work	4	B060910R
4		X	**Elective-III, IV, V (Choose any THREE papers)** B061001T/ B061002T/ B061003T/ B061004T/ B061005T/ B061006T/ B061007T/ B061008T/ B061009T		
			Decision Theory and Bayesian Inference	4	B061001T
			Advanced Sample Survey	4	B061002T
			Quadratic Forms and Sequential Statistical Inference	4	B061003T
			Limit Theorems and Stochastic Process	4	B061004T
			Data Science	4	B061005T
			Reliability Theory and Survival Analysis	4	B061006T
			Linear Models and Regression Analysis	4	B061007T
			Research Methodology	4	B061008T
			Marketing Research Statistics	4	B061009T
			Practical	4	B061010P
			Research Project Work	**8**	**B061011R**

:: Programme Outcomes (POs) ::

After completing B.Sc. (Honours)/ B.Sc. (Honours with Redearch), M.Sc. (Statistics) the student will

1. have aptitude to apply statistical tools at a number of data generating fields in real life problems.

2. able to handle large data sets and carry out data analysis using software and programming language.

3. able to describe complex statistical ideas to non-statisticians.

4. able to handle and analyse large databases with computer skills and use their results and interpretations to make practical suggestions for improvement.

5. able to get wide range of job opportunities in industry as well as in government sector.

6. able to take prominent roles in a wide spectrum of employment and research by using their wide range of statistical skills, including problem-solving, project work and presentation skills.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: -**B060701T**	Course Title: **Real Analysis and Matrix Algebra**	
Credits: 04	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Axiomatic introduction of real number system as an ordered field with order completeness property, Archimedean property, Extended Real number system, Schwartz Inequality, Euclidean space R^k, Wiestrass Theory in R^1, Limit point of a sequence, Cauchy's General Principle of convergence in R^1.

Unit 2
Riemann Integrals, Properties of Darboux Sums, Conditions of Integrability, Classes of Integrable Functions, Algebra of Integrable Functions, Riemann-Stieltges Integral, Existence Theorem

Unit 3
Algebra of Matrices, Trace, Determinants, Inverse, Generalised Inverse, Rank, Linear Equations, Characteristic Roots and Vectors.

Unit 4
Vector Spaces, Subspaces, Linear Independence and Dependence of Vectors, Dimension and Basis of a Vector Space, Gram-Schmidt Orthogonalization.

Books Recommended :
1. Mathematical Analysis—T.M. Apostol
2. Principles of Mathematical Analysis—Walter Rudin
3. Topics in Algebra of Matrices—S. Biswas
4. Linear Algebra—A.R. Rao and P. Bhimasankaram
5. Matrix Algebra Useful for Statistics—S.R. Searle
6. A Course of mathematics Analysis—Shanti Narayan and P.K. Mittal
7.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: STATISTICS		
Course Code: -**B060702T**	Course Title: **Probability and Distribution Theory**	
Credits: 04	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Classes of sets, sequences of sets, limit superior and limit inferior of a sequence of sets, fields, sigma field, minimal sigma field, Borel sigma field on real line. Event and event space, sample space, probability measure, properties of measure, independent events, conditional probability and Bayes' theorem.

Unit 2
Measurable functions, random variables, functions of random variables, induced probability measure. Distribution function, joint and marginal and conditional distribution in R^n. Expected values, moments, some related inequalities.

Unit 3
Probability generating function, moment generating function, characteristic function and their properties: uniqueness, continuity and inversion with application. Weak (WLLN) and Strong (SLLN) Law of Large Numbers, Khintchin's Theorem and Kolmogorov Strong Law of Large Numbers, Borel zero- one Law, Borel – Cantelli lemma.

Unit 4
Transformation of random variables. Probability sampling distributions of Chi-square, t and F statistics and their distributions. Order statistics and their distributions.

Books Recommended :
1. Bhat, B.R.(1981).Modern Probability Theory, III Edition, New Age International(P).
2. Das,K.K and Bhattacharyajee,D.(2008). A Treatise On Statistical Inference And Distributions, Asian Books, New Delhi.
3. Feller,W.(1969). Introduction To Probability And Its Applications, Vol.II, Wiley Eastern Ltd.
4. Hogg,R.V.,Craig,A. and Mckean,J.W.(2005).Introduction To Mathematical Statistics, Sixth Edition, Pearson.
5. Johnson,S.and Kotz(1995).Distributions In Statistics, Vol.-I,II And III,Houghton And Miffin.
6. Loeve,M.(1978). Probability Theory (Springer Verlag), Fourth Edition.
7. Mood,A.M., Graybill,F.A. and Boes,D.C.(1974).Introduction To Theory Of Statistics, Third Edition, Mc Graw Hill.
8. Mukhopadhyaya,P.(1996). Mathematical Statistics, Calcutta publishing house.
9. Rohatgi,V.K.(1984). An introduction to probability theory and mathematical statistics, Wiley Eastern.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: STATISTICS		
Course Code: -**B060703T**	Course Title: **Sampling Theory**	
Credits: 04	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Review of simple random sampling with and without replacement. Determination of sample size. Sampling with varying probabilities, ordered and unordered estimates, Des Raj estimator ,Horvitz-Thompson estimator.

Unit 2
Stratified random sampling, different types of allocation, allocation problems, problem of allocation with more than one item. Effect of deviation from optimum allocation, construction of strata, number of strata, method of collapsed strata, post stratification. Systematic sampling (circular, population with trend), domain estimation in SRS. Comparison with SRS and stratified random sampling. Cluster sampling with equal and unequal cluster sizes, estimation of mean and variances. Efficiency of cluster sampling in terms of intra- class correlation coefficient.

Unit 3
Ratio method of estimation- concept of ratio estimators, ratio method of estimation in simple random sampling, their bias, variance/MSE. Conditions under which ratio estimators are BLUE, ratio estimators in stratified random sampling. Regression method of estimation-concept of regression estimators, difference estimator, regression estimator in SRS, their bias, variance/MSE, regression estimator in stratified random sampling.

Unit 4
Two stage sampling with equal first stage units and unequal first stage units- estimator of population mean and variance/MSE. Determination of optimal sample sizes at both the stages. Double sampling and its use in ratio and regression method of estimation. Non-sampling errors, error in surveys, observational error: mathematical model of measurement of observational error. Incomplete samples . Effect of non-response.

Books Recommended :
1. Cochran,W.G.(1997). Sampling Techniques, Wiley Eastern, New Delhi.
2. Des Raj and Chandok,P. (1998). Sampling Theory, Narosa, New Delhi.
3. Mukhopadhyay, P.(1998). Theory And Methods Of Survey Sampling, Pentice Hall of India, New Delhi.
4. Murthy,M.N.(1977). Sampling Theory And Methods, Statistical Publishing Society, Kolkata.
5. Sukhatme,P.V.,Sukhatme,B.V., Sukhatme, S. and Asok ,C.(1984).Sampling Theory Of Surveys And Applications,Iowa State University press and IARS.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: STATISTICS		
Course Code: -**B060704T**	Course Title: **Computer Science**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit1

Introduction to Computer, Evolution of Computer Technology, Types of Computers, Basic elements of Computer, Components of Computer, Generations of Computer and Computer languages, Introduction to Statistical Software e.g. SPSS, STATA etc.

Unit2

Introduction to R: What is R? Installation of R and its packages, R environment, creation of data objects (vector, matrices, arrays, lists and data frames) in R, Management of data through R, Data Import and export. Basic manipulation of data and summary.

Unit3

Using R-Graphical representation of data, Tabulation of data, Descriptive Statistics, Summarizing Data, Creating & Editing Charts, Modifying data values, Sorting & Selecting Data Values, Chi- Square and t-test.

Unit 4

Data Analysis in R-Correlation & Regression, One-way ANOVA, Factorial ANOVA, Nonparametric Tests, Discriminant Analysis, Factor Analysis, Cluster Analysis.
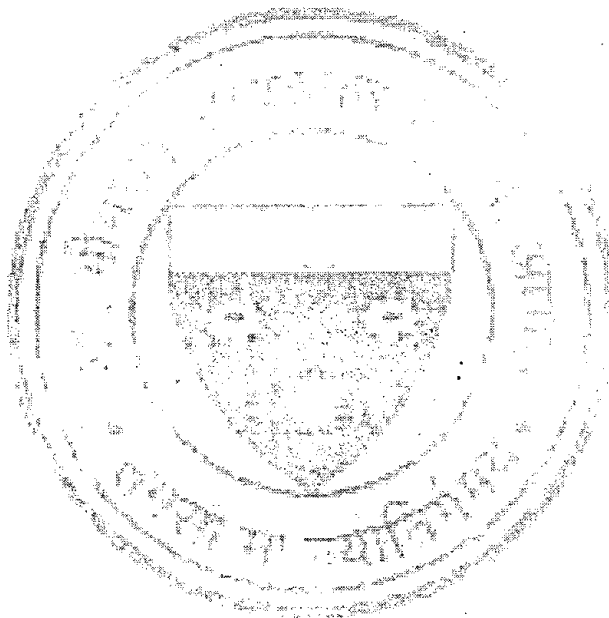
Reference Books:
1. Argyrous, G. (2012), Statistics for Research: With a Guide to SPSS, Sage South Asia; Third Edition.
2. Cox & Lambert (2010), Microsoft Word 2010: Step by Step, Microsoft Press.
3. George Darren: SPSS for Window Step by Step.
4. Griffith, A. (2007), SPSS For Dummies, Published by Wiley Publishing, Inc.
5. Hothorn,T and Everitt, B.S.(2014). A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC Press, Boca Raton, Florida, USA, 3rd edition.
6. Knell, R.J. (2013), Introductory R: A Beginner's Guide to Data Visualisation and Analysis using R.
7. Norton, P. (2010), Introduction to Computers, McGraw Hill Education (India) Private Limited.
8. Patric L. . A. K. and Feeney B. C.: A Simple Guide to SPSS.
9. Sheridon J Coaks:, SPSS.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: STATISTICS		
Course Code: -**B060705P**	Course Title: **Practical**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **100 (End Exam)**	Min. Marks: **36 minimum in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-8.		

Detailed Syllabus

Practical Excersices based on all the Theory papers of Seventh Semester

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: STATISTICS		
Course Code: -**B060801T**	Course Title: **Statistical Inference-I**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:

The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:

After successful completion of this course, student will be able to:

1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1

Data reduction: Data reduction, Sufficiency, Neyman factorization theorem with examples, Completeness, bounded completeness, Exponential families of distributions and Pitman families, Sufficient partition, Minimal sufficiency and Ancillary statistic, Basu's theorem,

Unit 2

Point Estimation: Estimability of parametric functions, Unbiased Estimator, Efficeincy of Estimators, Minimum Variance Unbiased Estimators (UMVUES), necessary and sufficient conditions for MVUE, Rao-Blackwell and Lehmann-Scheffe theorem, Fisher Information for one and several parameters models, Lower bounds for variance of estimators, Frechet-Cramer and Rao (FCR), Chapman, Robbins and Kiefer (CRK) and Bhattacharya lower bounds

Unit 3

Asymptotic Inference: Consistency and asymptotic relative efficiency of estimators, Consistent and Asymptotically normal (CAN) estimators, BAN estimators and their properties, Invariance of consistency under continuous transformation.

Unit 4

Method of Estimation: Maximum Likelihood Estimation: Method of Maximum Likelihood Estimation, Optimal properties of maximum likelihood estimators, large sample properties of ML estimators, Method of Moments, Method of Chi-sqaure, Method of least squares and their applications

Books Recommended :

1. Kale, B. K.(1999) : A first course on parametric inference,.Narosa Publishing House.
2. Rohatagi, V. (1988): An Introduction to probability and mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)
3.. Lehmann E.L. (1983) : Theory of Point Estimation
4. Rao C.R. (1973) : Linear Statistical Inference and Its Applications
5. Berger J.C. (1980) : Statistical Decision Theory
6. Wilks S.S. (1962) : Mathematical Statistical
7. Forguson T.S. (1967) : Mathematical Statistics–A Decision Theoretic Approach

Programme/Class: M.Sc.	Year: Fourth	Semester: Eighth
Subject: STATISTICS		
Course Code: -B060802T	Course Title: Linear Estimation and Design of Experiments	
Credits: 04	Core: Compulsory	
Max. Marks: 25 (CIE) + 75 (End Exam)	Min. Marks: 36 with minimum 27 in End Exam	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Course Outcome:

The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:

After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1

The Linear Model, Estimable functions, Estimation and Error space, Best estimates, Gauss- Markov theorem, Variance and Covariance of Estimates, Sums of Squares, Degrees of Freedom, Linear Hypothesis, Estimable Linear Hypothesis, The Generalized t-test and Generalized F-test,

Design of Experiment:

Unit 2

Planning of experiment, Completely Randomized Design, Randomized Block Design, Latin Square Design. Analysis of Covariance with One Concomitant Variable.

Unit 3

General Incomplete Block Design, Balanced Incomplete Block Design, Partially Balanced Incomplete Block Design (with two associate classes), Split Plot Design.

Unit 4

Symmetric and Asymmetrical Factorial Design, Yates method of analysis for 2^n and 3^n Design, Partial and total confounding in 2^2, 3^2 and 3^3 Design. Fractional Replication in 2^n Design.

Books Recommended :

1. Cochran, W.G. and Cox, G.M. (1959). Exponential Designs, Asia Publishing House,Singapore.
2. Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments, Wiley EasternLimited.
3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments, Springer. FirstIndian Reprint 2006.
4. Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern, NewDelhi.
5. Montgomery, D.C. (2005). Design and Analysis of Experiments, Sixth Edition, JohnWiley and Sons.

Programme/Class: M.Sc.	Year: Fourth	Semester: Eighth
Subject: STATISTICS		
Course Code: -B060803T	Course Title: Multivariate Analysis	
Credits: 04	Core: Compulsory	
Max. Marks: 25 (CIE) + 75 (End Exam)	Min. Marks: 36 with minimum 27 in End Exam	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Multivariate normal distribution, moment generating function and characteristic function, marginal and conditional distributions, multiple and partial correlation coefficients.

Unit 2
Maximum likelihood estimators of the mean vector and covariance matrix. Distribution of sample mean vector. Wishart distribution (without derivation) and its properties.

Unit 3
Hotelling T^2-statistic as a function of likelihood ratio criterion, its distribution, optimum properties and applications. Generalised variance, distribution of sample generalised variance.

Unit 4
Classification problems, Fisher's discriminant function. D^2-statistic and its application. Analysis of dispersion, and testing of general linear hypothesis, equality of mean vectors, Wilk's lamda effect, equality of dispersion matrices. Principal components, maximum likelihood estimates of principal components and their variances.

Books Recommended :

1. Anderson,T.W.(1958). An Introduction To Multivariate Statistical Analysis, Second Edition,Wiley.
2. Giri,N.C.(1977). Multivariate Statistical Inference, Academic Press, New York.
3. Johnson,R.A. and Wichern,D.W.(2003). An Introduction To Applied Multivariate Analysis, 5/e,Pearson Education.
4. Johnson,R.A. and Wichern,D.W.(1986). Applied Multivariate Analysis, Wiley.
5. Kshirsagar,A.M.(1972). Multivariate Analysis, Marcel-Dekker.
6. Morrison,D.F.(1976). Multivariate Statistical Methods, Mc Graw-Hill.
7. Singh,B.M.(2002). Multivariate Statistical Analysis, South Asian Publishers, New Delhi.
8. Srivastava,M.S. and Khatri,C.G.(1979). An Introduction To Multivariate Statistics, North Holland.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: STATISTICS		
Course Code: -**B060804T**	Course Title: **Data Analysis Using SPSS**	
Credits: 04	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit-1
Introduction to SPSS, Data analysis: general aspects, workflow, critical issues , SPSS GUI: windows, menus, commands - File management: SPSS native formats.

Unit-2
Input and data management , Data file import , Defining variables , Labelling variables and their values
Data manipulation - Preparing data for analysis: cleaning, data transformations, missing value management , SPSS output files , SPSS syntax files and script

Unit-3
Descriptive and graphical data analysis : Frequencies , Descriptives , Explore ,Crosstabs , Creating charts with SPSS
Statistical tests and Working with data files - Means , T-test , One-way ANOVA , Normality tests - Merging files , Split, filter and weight data, Comparing datasets

Unit-4
Introduction to correlation and regression :Linear correlation , Simple and multiple linear regression, Logistic regression, Time series

Unit-5
Introduction to multivariate analysis: Principal component analysis, Factor analysis, Cluster analysis, Discriminant analysis

Books
1. Margan G A: SPSS for Introductory Statistics; Uses and Interpretation.
2. Practical Work Book by Bristol Information Services: Introduction to SPSS for Windows.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: STATISTICS		
Course Code: **-B060805T**	Course Title: **Data Analysis Using R**	
Credits: 04	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit–I
R-Programming, Overview of R, R data Types & Objectives, Reading & Writing Data, Control Structures, Function, Scoping Rules, Loop Functions, Simulation. Writing functions, Looping in R, Operations on vectors and matrices.

Unit-II
Tabulation and Graphics to Display the Data Distribution with R (scatter plot, histogram, Q-Q Plot, P-P plot, Box Plot etc.). High level plotting functions, Low level plotting functions, Interactive graphic function. Measure of Statistical Distribution (measure of central tendency and Dispersion)

Unit-III
Generation of random numbers and simple inferences, Probability distribution, Sampling distributions- t-test, chi-square test, z-test, F-test, Parametric and non-parametric tests, Correlation & Regression, Analysis of Variance, longitudinal data (Random effect and mixed effect).
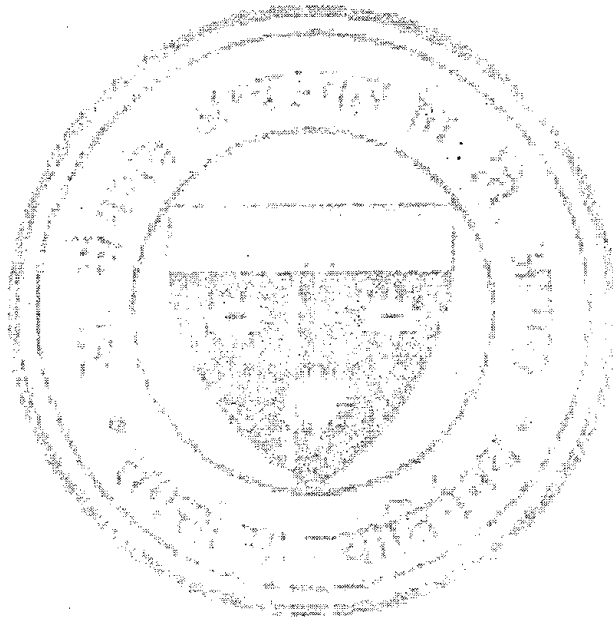
Unit-IV
Meta-Analysis (Systemic Review and meta regression analysis) Non parametric Inference (Bootstrap), Stochastic Process (Markov chain, Metropolis- Hastings and Gibbs sampler). Monte Carla computation, Simulation, Application of Monte Carlo methods to compute expected values of functions of random variables, such as Laplace transform, Fourier transform.

Recommended Books:
1. Reimann, C., Filzmoser, P., Garrett, R., & Dutter, R. (2011). *Statistical data analysis explained: applied environmental statistics with R*. John Wiley & Sons.
2. Schmuller, J. (2017). *Statistical Analysis with R For Dummies*. John Wiley & Sons.
3. Gareth, J., Daniela, W., Trevor, H., & Robert, T. (2013). *An introduction to statistical learning: with applications in R*. Spinger.
4. Dalgaard, P. (2020). *Introductory statistics with R*. Ripley, B. D. (2009). *Stochastic simulation*. John Wiley & Sons.
5. Tattar, P. N., Ramaiah, S., & Manjunath, B. G. (2016). *A Course in Statistics with R*. John Wiley & Sons.
6. Robert, C., & Casella, G. (2011). A short history of Markov chain Monte Carlo: Subjective recollections from incomplete data. *Statistical Science, 26*(1), 102-115.

7. Hothorn, T., & Everitt, B. S. (2006). *A handbook of statistical analyses using R*. Chapman and Hall/CRC.
8. Gilks, W. R., Richardson, S., & Spiegelhalter, D. (Eds.). (1995). *Markovchain Monte Carlo in practice*. CRC press
9. Rizzo, M. L. (2019). *Statistical computing with R*. Chapman and Hall/CRC.
10. Kohl, M. (2015). *Introduction to statistical data analysis with R*. London: bookboon. com

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: -**B060806T**	Course Title: **Data Analysis Using Python**	
Credits: 04	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit-1

Introduction to Python- Python data structures, data types, indexing and slicing, vectors, arrays, developing programs, functions, modules and packages, data structures for statistics, tools for statistical modeling, data visualization, data input and output.

Unit-2

Display of Statistical data with Python- Univariate and multivariate data, discrete and continuous distributions: binomial, Poisson, normal, Weibull. Sampling distributions: t, chi-square and F.

Unit-3

Hypothesis testing with Python- Test for means: t test for single and two samples, Wilcoxon and Mann-Whitney test, test for categorical data, one proportion and frequency tables, chi-square test for independence, relation between hypothesis and confidence intervals, one- and two -way ANOVA.

Unit-4

Statistical Modeling with Python-Correlation and Regression coefficients, simple and multiple regression analyses, model selection criteria, bootstrapping, generalized linear models.
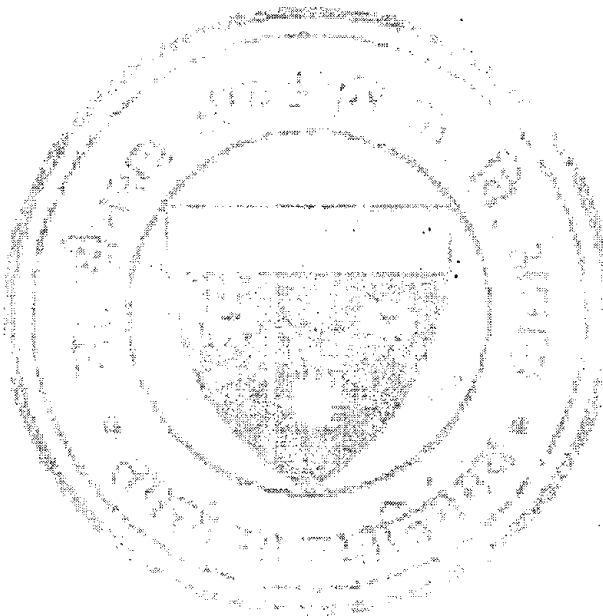
Books Recommended:

1. Haslwanter, T. (2016): An Introduction to Statistics with Python: with Applications in the Life Sciences, Springer.

2. Sheppard, K. (2018): Introduction to Python for Econometrics, Statistics and Data analysis, Oxford University press.

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: STATISTICS		
Course Code: -**B060807P**	Course Title: **Practical**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **100 (End Exam)**	Min. Marks: **36 minimum in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-8.		

Detailed Syllabus

Practical Excersices based on all the Theory papers of Eighth Semester

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: -**B060901T**	Course Title: **Statistical Inference–II**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Testing of Hypotheses: Errors of type I and II, Randomized and nonrandomized tests, level of significance, size of the test, p-value, power Function, Neyman-Pearson fundamental lemma and its applications, UMP tests, Families of distributions with Monotone Likelihood Ratio, UMP tests for one- Sided testing problems, UMP tests for one-parameter exponential families, Generalized Neyman-Pearson Lemma. Non-existence of UMP tests for simple null against two-sided alternatives in one parameter exponential family, Unbiased Test, UMPU tests for one-parameter exponential family, one- and two-sided testing problems

Unit 2
Testing of Hypotheses (Multi-parameter Case): Composite hypothesis and UMPU test, Similar tests, Neyman Structure, Invariance tests and UMP invariant tests, Likelihood ratio test, Asymptotic distribution of LRT Statistic, Consistency of large sample test, Asymptotic properties of large sample test

Unit 3
Interval Estimation: Confidence Interval, confidence sets, relation with hypothesis testing, confidence level, Construction of confidence intervals with pivots and shortest expected length, Uniformly most accurate (UMA), Confidence intervals for the parameter for Normal, Exponential, Binomial and Poisson distributions. CI for quantiles, concept of tolerance limits and examples.

Unit 4
Non-parametric Test: Non-parametric estimation of distribution function, Consistency and relative efficiency, Glivenko-Cantelli fundamental theorem of statistics, The Mann-Whitney U test, Application of U-statistic to rank tests, One sample and two sample Kolmogorov-Smirnov tests. The Kruskal-Wallis One-Way ANOVA Test, Friedman's Two-Way Analysis of Variance by ranks. Efficiency criteria, Theoretical basis for Calculating the ARE, Pitman ARE.

Books Recommended :
1. Lehmann, E.L.(1986) : Testing statistical hypotheses (Student Edition).
2. Rao, C.R. (1973) : Linear Statistical inference.
3. Goon A.M., Gupta M. dasgupta B. (1980) : An Outline of Statistical Theory

4. Jacks, S. (1971) : Theory of statistical Inference, John Wiley & Sons, New York.

Programme/Class: M.Sc.	Year: Fifth	Semester: Ninth
Subject: STATISTICS		
Course Code: -B060902T	Course Title: Operations Research	
Credits: 04	Core: Compulsory	
Max. Marks: 25 (CIE) + 75 (End Exam)	Min. Marks: 36 with minimum 27 in End Exam	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Definitions of Operation Research, History of Operations Research, Scope of Operations Research, Models in Operations Research, LPP, Hyperplane, Convex Sets, Convex Functions, Convex Null, Local and Global Extrema.

Unit 2
Network analysis, Inventory Control—Meaning and Importance, Various Costs Involved in Inventory Control, Deterministic Models, Probabilistic Inventory Models, Models With Lead time, Inventory Models with Price Breaks.

Unit 3
Essential Features of Queuing System, Steady State, Transient State, Distribution of Arrivals, Inter-Arrivals and Waiting Time, Queuing Models $M/M/1$: (∞/FIFO) and $M/M/1$: (N/FIFO).

Unit 4
Dynamic programming, Dual Simplex method, simple problems on Integer programming.

Books Recommended :
1. Operations Research—B.S. Goel and S.K. Mittal
2. Operations Research—K. Swarup, P.K. Gupta and M.Mohan
3. Operations Research—S.D. Sharma
4. Operations Research : Theory and application—J.K. Sharma
5. Operations Research : An Introduction—H.A. Taha
6. Linear Programming—G. Hedley

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: -**B060903T**	Course Title: **Data Mining**	
Credits: **04**	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1

Introduction, Relational Databases, Data Warehouse, Transactional Databases, Advanced Data and Information Systems and Advanced Applications.Data Mining Functionalities. Concept/Class Description: Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Prediction, Cluster Analysis, Outlier Analysis, Evolution Analysis. Classification of Data Mining Systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or Data Warehouse System, Major Issues in Data Mining.

Unit 2

Data Preprocessing, Descriptive Data Summarization: Measuring the Central Tendency, Measuring the Dispersion of Data, Graphic Displays of Basic Descriptive Data Summaries. Data Cleaning: Missing Values, Noisy Data, Data Cleaning as a Process. Data Integration and Transformation: Data Integration, Data Transformation. Data Reduction: Data Cube Aggregation, Attribute Subset Selection, Dimensionality Reduction, Numerosity Reduction. Data Discretization and Concept Hierarchy Generation: Discretization and Concept Hierarchy Generation for Numerical Data, Concept Hierarchy Generation for Categorical Data.

Unit 3

Mining Frequent Patterns, Associations, and Correlations,Market Basket Analysis: Frequent Itemsets, Closed Itemsets and Association Rules, Frequent Patterns Mining: Efficient and Scalable Frequent Itemset Mining Methods: The Apriori Algorithm: Finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, Mining Frequent Itemsets without Candidate Generation, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed Frequent Itemsets. Mining Various Kinds of Association Rules: Mining Multilevel Association Rules, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses. From Association Mining to Correlation Analysis: From Association Analysis to

Correlation Analysis. Constraint-Based Association Mining: Metarule-Guided Mining of Association Rules, Constraint Pushing: Mining Guided by Rule Constraints.

Unit 4

Issues Regarding Classification and Prediction: Preparing the Data for Classification and Prediction, Comparing Classification and Prediction Methods, Classification by Decision.Tree Induction: Decision Tree Induction, Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Bayesian Classification: Bayes' Theorem, Naïve Bayesian

Classification, Bayesian Belief Networks, Training Bayesian Belief Networks, Rule-Based Classification: Using IF-THEN Rules for Classification, Rule Extraction from a Decision Tree, Rule Induction Using a Sequential Covering Algorithm,Associative Classification: Classification by Association Rule Analysis, k-Nearest-Neighbor Classifiers, Case-Based Reasoning,

Unit 5

Prediction: Linear Regression, Nonlinear Regression, Other Regression-Based Methods, Accuracy and Error Measures: Classifier Accuracy Measures, Predictor Error Measures, Evaluating The Accuracy of a Classifier or Predictor: Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Ensemble Methods—Increasing the Accuracy: Bagging, Boosting, Model Selection: Estimating Confidence Intervals, ROC Curves.

Reference Book:
1. Data Mining: Concepts & Techniques (Second Edition,Jiawei Han &Micheline Kamber (Morgan Kaufman Publisher, 2006)
2. Principles of Data Mining, David Hand, HeikkiMannila, Padhraic Smyth (Printice Hall of India Private Limited, 2007)
3. Data Mining, VikramPudi& P. Radha Krishna(Oxford University Press, 2009)

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: -**B060904T**	Course Title: **Population Studies**	
Credits: **04**	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Definition and scope of demography, sources of demographic data: census, registration and sample surveys. Errors in census and vital statistics and their adjustments, Whipples and Myer's indices. Chandrasekharan Deming formula to check completeness of registration data.

Unit 2
Fertility, its measures. Measures of reproduction and replacement. Fertility models. Distribution of time of first birth/conception, number of births/ conceptions in a specified time; inter-live birth intervals (for both homogeneous and non-homogeneous groups of women), estimation of parameters.

Unit 3
Mortality, its measures. Standerdised death rates. Life table, its type. Construction of complete and abridged life tables. Makeham's and Gompertz curve.

Unit 4
Migration rates and ratios. Method to estimate intercensal migration using vital statistics, survival ratio and growth rate. Migration models.

Unit 5
Theory of stable population, quasi and stationary population. Stochastic models of population growth. Growth curves and methods of their fitting. Population estimates and projection. Component method of population projection.

Books Recommended :
1. Benjamin, B.(1969). Demographic Analysis, George, Allen And Unwin.
2. Biswas, S. (1988). Stochastic Processes In Demography And Applications, Wiley Eastern, New Delhi.
3. Chiang, C.L.(1968). Introduction To Stochastic Processes In Biostatistics, John Wiley, New York.
4. Cox, P.R. (1970). Demography, Cambridge University Press.
5. Keyfitz, N.(1977). Appplied Mathematical Demography, Springer Verlag.
6. Kumar,R. (1986). Technical Demography, Wiley Eastern Ltd.
7. Pathak, K.B. and Ram, F. (1992). Techniques Of Demographic Analysis, Himalayan Publishing House, Bombay.
8. Shryock,H.S. (1976). The Methods And Materials Of Demography, Academic Press, New York.
9. Spiegelman, M. (1969). Introduction To Demographic Analysis, Harvard University Press.
10. Wolfenden,H.H. (1954). Population Statistics And Their Compilation, American Acturial Society.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: STATISTICS		
Course Code: -**B060905T**	Course Title: **Medical Statistics**	
Credits: **04**	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit-1
Introduction to medical statistics- Definition and uses, Statistical Data, Types of Data: attributes and variables, discrete & continuous data, Primary data, Secondary data, Different types of scales- nominal, ordinal, ratio and interval. Descriptive Epidemiological Studies: Case report, Case series, Correlation studies, Cross sectional studies, Design, analysis, merits and demerits of all these studies , Analytical Epidemiological studies – Case control & Cohort

Unit-2
Measuring the occurrence of disease, Measures of morbidity - prevalence and incidence rate, association between prevalence and incidence, uses of prevalence and incidence, Measures of exposure effect – Relative and absolute measures of exposure effect, Relative measures - Risk ratio rate ratio and odds ratio , Absolute measures – Attributable risk Attributable risk percentage population excess risk

Unit-3
Clinical Epidemiology: Definition, reliability, validity, sensitivity, specificity, predictive values. Observational studies: retrospective, cross sectional and prospective studies. Likelihood ratio test, selection and interpretation of diagnostic test. Deciding on the best therapy. ROC curves, multiple and parallel test. Screening for diseases, Critical approach, and Meta analysis. Epidemiological Models- Epidemometric studies- Deterministic epidemic models: simple, General Recurrent- Stochastic epidemic models.
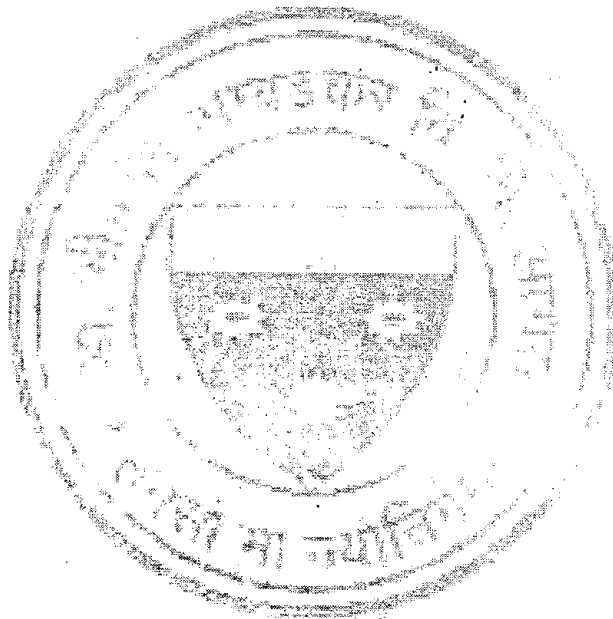
Unit-4
Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials. Sample size calculation problem in different study designs

Books
1. K J Rothman and S Greenland (ed.): Modern Epidemiology, Lippincott-Raven.
2. S. Selvin (1996): Statistical Analysis of Epidemiology data, Oxford University Press.
3. D Mcneil (1996): Epidemiological Research Methods, Wiley and sons.
4. J F Jekel, J G Elmore, D L Katz (1996): Epidemiology, Biostatistics and Preventing Medicine,
5. Collett, D. (2003). Modelling Survival Data in Medical Research, Chapman & Hall/CRC.
6. Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall.
7. Friedman, L.M., Furburg, C. and DeMets, D.L. (1998). Fundamentals of Clinical Trials,\ Springer Verlag.

8. Gordis Leon (1996). Epidemiology Elsevier Philadelphia.
9. Greenland & Rothman Kenneth (2008). Modern epidemiology Wolters Kluwer Health (India) Pvt Ltd New Delhi.
10. Indrayan, A. (2008). Medical Biostatistics, 2nd ed., Chapman & Hall/CRC.
11. Lee, Elisa, T. (1992). Statistical Methods for Survival Data Analysis, John Wiley & Sons.
12. Miller, R.G. (1981). Survival Analysis, John Wiley & Sons.
13. Robert F. Woolson (1987). Statistical Methods for the analysis of biomedical data, John Wiley & Sons.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**

Subject: STATISTICS

Course Code: -**B060906T**	Course Title: **Official Statistics**

Credits: 04	Core: **Elective Optional**

Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**

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

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1

Introduction to Indian and International Statistical System, Methods of Collection of Official Statistics, Their Reliability and Limitations. Role, Functions and Activities of Central and State Statistical Organizations, Organization of Large Scale Sample Surveys.

Unit 2

Role of national Sample Survey Organization, Other Agencies Responsible for Data Collection and Their Main Functions, Principal Publications on various Topics of Data Collection, Scope and Contents of Population Census of India.

Unit 3

Population Statistics, Agricultural Statistics, Medical Statistics, Industrial Statistics, Trade Statistics, Price Statistics.

Unit 4

Statistics of Labour & Employment, Statistics of Transport and Communication, Financial and banking Statistics, Miscellaneous Statistics.

Unit 5

National Income and Its Computation, Utility and Difficulties in Estimation of National Income.

Books Recommended :

1. Basic Statistics Relating to Indian Economy (CSO) 1990
2. Guide to Official Statistics (CSO) 1999
3. Statistical System in India (CSO) 1995
4. Principles and Accommodation of National Population Censuses (UNESCO)
5. National Accounts Statistics—Sources and Health (CSO) 1980

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: STATISTICS		
Course Code: -**B060907T**	Course Title: **Econometrics**	
Credits: 04	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
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Detailed Syllabus

Unit 1

Definitions of Econometrics, Scope of Econometrics, Division of Econometrics, Models and Methodology of Econometric Research.

Unit 2

Two Variable Linear Model, Least Square and Maximum Likelihood Estimation, Properties of Estimators, Tests of Significance and Confidence Intervals of Parameters, Analysis of Variance in Regression, Extension of Two Variable Model.

Unit 3

General Linear Model, Least Square and M.L.E. Estimation, Properties, Significance Tests and Confidence Intervals, Generalized Least-Squares (AITKEN) Estimator.

Unit 4

Nature of Heteroscedasticity, Consequences, Detection and Remedial Measures of Heteroscedasticity, Introduction of Auto Correlation, OLS Estimation in Presence of Auto Correlation, Detection and Remedial Measures of Auto Correlation.

Unit 5

Nature of Multi Collinearity, Practical Consequences, Detection and Remedial Measures of Multicollinearity, Simultaneous Equalition Systems.

Books Recommended :

1. Basic Econometrics—D.N. Gujarati
2. Econometric Methods—J. Johnston
3. Theory of Econometrics—A. Koutsoyiannis

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060908T**	Course Title: **Acturial Statistics**	
Credits: **04**	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
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6. Understand the

Detailed Syllabus

Unit-1
Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory, models for individual claims and their sums.

Unit-2
Survival function, Uncertainty of age at death, time until-death for a person, curate future lifetime, force of mortality. Life table and its relation with survival function, life table characteristics, assumptions for fractional ages, some analytical laws of mortality, select and ultimate life table.

Unit-3
Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding. Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

Unit-4
Life insurance: Insurance payable at the moment of death and at the end of the year of death level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities.

Unit-5
Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. A brief outline of payment premiums and net premiums, Gross premiums and provisions. Profit testing- Determining provisions using profit testing. Factor affecting mortality and selections.

Books
1. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1997). Actuarial Mathematics. Society of Actuaries, Itasca, Illinois, U.S.A.
2. Daykin, C. D., Pentikainen, T. and Pesonen, M. (1993). Practical Risk Theory for Actuaries. Chapman & Hall/CRC.
3. Deshmukh, S.R. (2009). Actuarial Statistics: An Introduction Using R, University Press, India.

4. Dickson, C. M. D. (2005). Insurance Risk and Ruin (International Series no.1 Actuarial Science), Cambridge University Press.
5. Klugman,S. A., Panjer, H. H., and Willmotand, G. E. (2019). Loss Models: From Data to Decisions. Willy publication.
6. Neill, A. (1977). Life Contingencies, Heinemann.
7. Rotar, V.I. (2015). Actuarial Models: The Mathematics of Insurance, 2nd ed., CRC Press, New York.
8. Spurgeon, E.T. (1972). Life Contingencies, Cambridge University Press.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: -**B060900P**	Course Title: **Practical**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **100 (End Exam)**	Min. Marks: **36 minimum in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-8.		

Detailed Syllabus

Practical Excersices based on all the Theory papers of Ninth Semester

Programme/Class: **M.Sc.**		Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**			
Course Code: -**B061001T**		Course Title: **Decision Theory & Bayesian Inference**	
Credits: **04**		Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**		Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.			

Course Outcome:

The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:

After successful completion of this course, student will be able to:

1. Understand the role of real numbers
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Detailed Syllabus

Unit -1

Decision theoretic problem as a game, basic elements, Loss function, Risk function, Randomised and Non-Randomised Decision Rules, Admissible Decision Rule, Complete, Essential complete and minimal complete classes of decision rules and their relationship, Minimax and Bayes decision rules, Estimation testing viewed as decision rule problem.

Unit-2

Bayes and minimax estimators. Minimax and Bayes tests in simple cases, relationship of Bayes and minimax decision rules, optimal decision rules, Unbiasedness, invariance ordering, Bayes and Minimax principles, generalized Bayes rules, extended Bayes rules, limit of Bayes rules. Admissibility, Completeness, minimal complete class, separating and supporting hyper plane theorems, Complete class Theorem, equalizer rules and examples, minimax theorem.

Unit-3

Review of Basic Probability Concepts, Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem, Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Prior and posterior distributions, Improper priors, non-informative (default) priors, invariant priors. Jeffery's prior, Conjugate prior families Bayes estimators under squared error loss function, posterior variance and Bayes risk. Parametric Empirical Bayes, Bayesian inference, summary through posterior, predictive inference, credible sets, testing of hypotheses. Comparison with classical procedures, Admissibility and minimaxity of Bayes and generalized Bayes procedures.

Unit-4

Bayesian sufficiency, improper prior densities, Natural conjugate Bayesian densities (NCBD), posterior odd ratio, HPD regions, Bayesian inference for Normal populations, Bayesian calculation, Monte-Carlo Integration and Markov chain Monte Carlo techniques. Gibbs sampling and Metropolis algorithm, Applications in real-life situations, Bayesian inference using software packages.

Books:

1. Hogg, R. V. and Craig, A. T. (2004): Introduction to Mathematical Statistics, Pearson Edward (Indian Print).

2. Rohatgi, V. K. and Saleh A. K. Md. E (2001). An Introduction to Probability and Statistics, Wiley, New York.

3. Berger, J.O. (1993) Statistical Decision Theory and Bayesian Analysis, Springer Verlag.

4. Bernando, J.M. and Smith, A.F.M. (1994). Bayesian Theory, John Wiley and Sons.

5. Box, G.P. and Tiao, G.C. (1992). Bayesian Inference in Statistical Analysis, Addison-Wesley.

6. Gemerman, D and Lopes, H. F. (2006) Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.

7. Leonard, T. and Hsu, J.S.J. (1999) Bayesian Methods, Cambridge University Press.

8. Robert, C.P. (1994). The Bayesian Choice: A Decision Theoretic Motivation, Springer.

9. Robert, C.P. and Casella, G. (2004) Monte Carlo Statistical Methods, Springer Verlag.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
	Subject: STATISTICS	
Course Code: -**B061002T**		Course Title: **Advanced Sample Surveys**
Credits: 04		Core: **Elective Optional**
Max. Marks: **25 (CIE) + 75 (End Exam)**		Min. Marks: **36 with minimum 27 in End Exam**
	Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0.**	

Course Outcome:

The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:

After successful completion of this course, student will be able to:
1. Understand the role of real numbers
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3. Learn about the methods of
4. Learn about the applications of
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Detailed Syllabus

Unit 1

Fixed Population Approach :
   (a) Unified Theory of Sampling : Inference Aspect of Sample Survey, Sampling Designs and Sampling Schemes, Correspondence; Classes of Estimators, Homogeneous Linear Estimators and Condition of Unbiasedness; Godambe's UMV Non-Existence and Existence Theorems Under Restricted Conditions Relating to Labeled Populations, Basu's Difference Estimator. Sufficiency, Completeness, Admissibility of Estimators in Survey Sampling. Optimal Estimators in Useful Sampling Designs.
   (b) Unbiased Ratio and Regression Type Estimators, Multivariate Ratio and Regression Methods of Estimation, Product Estimator, Optimum Properties of Ratio and Regression Estimators. Regression Analysis and Categorical Data Analysis With Data From Complex Surveys. Bias Adjustment in Ratio Estimator Due to Murthy, Beale and Tin. Jackknife Ratio Estimator, Olkin's Multivariate Ratio Estimator. Self Weighting Designs.
   (c) Integration of Different Principles and Methods of Sampling in Adopting Composite Sampling Procedures in Actual Practice. Integration of Surveys—Lahiri and Keyfitz's Procedures. Variance Estimation with Complex Designs. Taylor's Series Linearization, Balanced Repeated Replication, Jackknife and Bootstrap Methods.

Unit 2

Model Based Approach and Prediction Approach : Inference Under Super-population Model, Concept of Designs and Model Unbiased Estimation, Traditional Model-Based and Optimal Estimators Under Various Useful Sampling Designs. Prediction Approach, Predicting a Super Population Mean.

Unit 3

Bayesian Theories in Finite Population : Non-Informative Bayesian Approach, Extension of Polya Posterior, Empirical Bayes Estimation, Estimation of Stratum Means, Hierarchical Bayes Estimation.

Unit 4

Small Area Estimation : Small Area Estimation—Direct Estimators, Synthetic Estimators, Composite Estimators, Repeated Sampling, Balanced Repeated Replication, Jackknife and Bootstrap Methods.
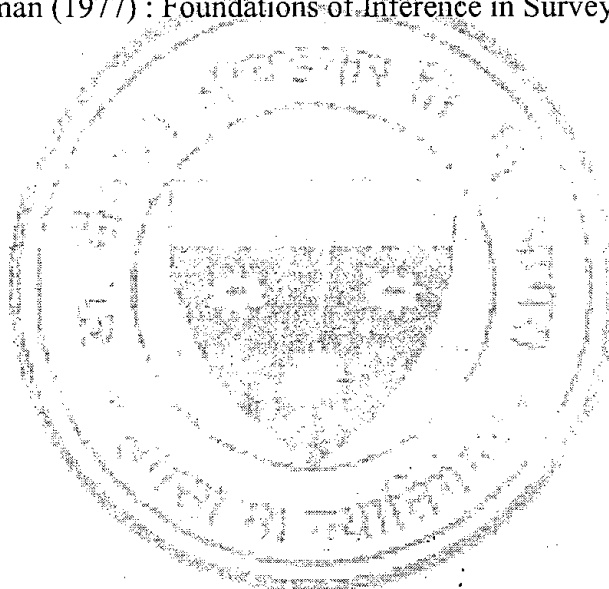
Calibration Approach : Introduction to Calibration Estimators, Calibration Estimators Based on Functional Form, With Restricted Weights, Robustness Aspects, Extended Calibration Estimators, Cosmetic and Calibration Estimators, Model Based Calibration Estimators, Estimation of Distribution Function and Quadratic Finite Population Function.

Unit 5

Large-Scale Surveys : Organizational Aspects of Planning Large-Scale Sample Surveys, Non-Sampling Errors, Non-Response. Familiarity with NSS Work and Some Specific Large-Scale Surveys. Special Topics Include Wildlife Surveys, Non-Sampling Error Adjustment, Categorical Data Analysis and Practical Survey Examples.

Reference Books :

1. Cochran, W.G. (1977) : Sampling Techniques
2. Des Raj and Chandak (1999) : Sampling Theory
3. Mukhopadhyay, P. (1998) : theory and Methods of Survey Sampling
4. Mukhopadhyay P. (2007) : Survey Sampling
5. Sarndal, C.E. and Swensson, B. and Wretman, J.H. (1992) : Model Assisted Survey Sampling
6. Sukhatme, P.V. and Sukhatme, B.V. (1992) : Sampling Theory of Surveys With Applications
7. Meeden, G, Ghosh, Malay (1997) : Bayesian Methods in Finite Population Sampling
8. Cassel, Sarndal, Wretman (1977) : Foundations of Inference in Survey Sampling

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: STATISTICS		
Course Code: -**B061003T**	Course Title: **Quadratic Forms and Sequential Statistical Inference**	
Credits: **04**	: Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
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4. Learn about the applications of
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Detailed Syllabus

Unit 1
Definite and semi definite quadratic forms, rank, index, and signature of a quadratic form. Equivalence, congruence relation of quadratic forms. Simultaneous reduction of quadratic forms.

Unit 2
Distribution of quadratic forms, characteristic function, independence of quadratic forms.

Unit 3
Introduction to sequential analysis: Fundamental ideas of sequential sampling, Sequential decision procedure, Sequential unbiased estimation,

Unit 4
Sequential probability ratio test (SPRT) for simple vs simple hypothesis, Construction of SPRT, Derivation of O.C. and A.S.N. function, Properties of SPRT.

Books Recommended :
1. Graybill, F. A. (1983). Matrices With Applications In Statistics, Second Edition.
2. Rao,C.R.(1973). Linear Statistical Inference And Its Applications, Second Edition, Wiley Eastern.
3. Rohatgi,V.K.(1986). An Introduction To Probability Theory And Mathematical Statistics, Wiley Eastern.
4. Searle, S.R.(1982). Matrix Algebra Useful For Statistics, John Wiley & Sons.
5. Singh,B.M.(2002). Multivariate Statistical Analysis, South Asian Publishers.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: -**B061004T**	Course Title: **Limit Theorems and Stochastic Processes**	
Credits: **04**	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
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Detailed Syllabus

Unit-1
Limit Theorems- Introduction, Modes of Convergence, weak law of large numbers, strong law of large numbers, limiting moment generating function, central limit theorem

Unit-2
One dimensional Central Limit Theorems: Lindeberg- Levy for i.i.d. random variables, Lyapunov (without proof), Lindeberg & Feller Theorem (without proof) for independent random variables.

Unit-3
Two state Markov sequences, Markov chains, determination of n-step transition probabilities, Chapman-Kolmogorov equations, first return and first passage probabilities, classification of states, communicating states, periodicity, stationary probability distributions and limit theorems for ergodic chains.

Unit-4
Continuous time Markov processes, Poisson (point) process, Inter arrival time distribution, Random walk and Brownian motion as a random walk, gambler's ruin problem. Birth and death processes, renewal processes,

Unit-5
Branching processes of discrete type, average size and variance of the population in the n-th generation, fundamental theorem of extinction. Wiener process, Arc-sine law, Martingales, stopping times, optional sampling theorem.

Books recommended:
1. VK Rohtagi- An introduction to probability and statistics, Wiley.
2. Cinlar, E. (1975). Introduction to Stochastic Processes, Prentice Hall.
3. Feller, W. (1968). Introduction to Probability and Applications, New Age India International.
4. Hoel, P. G., Port, S. C. and Stone, C. J. (1991). Introduction to Stochastic Processes, University Book Stall.
5. Karlin, S. and Taylor, H. M. (1995). A First Course in Stochastic Processes, Academic Press.
6. Medhi, J. (2012). Stochastic Processes, 3rd edition, New Age India International.
7. Ross, S. M. (1996). Stochastic Processes, Wiley.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: STATISTICS		
Course Code: -**B061005T**	Course Title: **Data Science**	
Credits: 04	Core: **Elective Optional**	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
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Detailed Syllabus

Unit 1
High Dimensional Space: Properties, Law of large number, Sphere and cube in high dimension, Generation points on the surface of sphere, Gaussians in high dimension, Random projection, Applications.

Unit 2
Random Graphs: Large graphs, G(n,p) model, Giant Component, Connectivity, Cycles, Non-Uniform models, Applications.

Unit 3
Singular Value Decomposition (SVD): Best rank k approximation, Power method for computing the SVD, PCA.

Unit 4
Random Walks and Markov Chains: Properties of random walks, Stationary distributions, Random walks on undirected graphs with unit edge weights, Random walks in Euclidean space, Markov Chain Monte Carlo.

Unit 5
Algorithm for Massive Data Problems, Frequency moments of data streams, Matrix algorithms using sampling.

Unit 6
The General Models for Massive Data Problems: Topic Models - Non-Negative Matrix Factorization, Latent Dirichlet Allocation (LDA), Hidden Markov Models, Graphical Models and Belief Propagation, Bayesian Networks, Markov Random Fields.

SUGGESTED BOOKS:
1. Fundamental of Machine Learning: K Phasinam, AK Singh, MK Sharma, T Singh.
2. Foundation of Data Science: Avrim Blum, John Hopcroft, and Ravindran Kannan

Programme/Class: M.Sc.	Year: Fifth	Semester: Tenth
Subject: STATISTICS		
Course Code: -B061006T	Course Title: Reliability Theory & Survival Analysis	
Credits: 04	Core: Elective Optional	
Max. Marks: 25 (CIE) + 75 (End Exam)	Min. Marks: 36 with minimum 27 in End Exam	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
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Detailed Syllabus

Unit-1
Definition of Reliability function, hazard rate function, pdf in form of Hazard function, Reliability function and mean time to failure distribution (MTTF) with DFR and IFR. Basic characteristics for exponential, normal and lognormal, Weibull and gamma distribution, Loss of memory property of exponential distribution. Reliability of System connected in Series, Parallel, k-out-of-n.

Unit -2
Reliability and mean life estimation based on failures time from (i) Complete data (ii) Censored data with and without replacement of failed items following exponential distribution Accelerated testing: types of acceleration and stress loading. Life stress relationships.

Unit-3
Basis of Survival analysis, Parametric methods - parametric models in survival analysis, Exponential, Weibull, Delta method in relation to MLE, Fitting of these models in one sample and two sample problems.

Unit-4
Regression models in survival analysis. Fitting of Exponential, Weibull, Non-parametric methods for estimating survival function and variance of the estimator viz. Acturial and Kaplan –Meier methods.Cox-proportional, hazard models. Model checking and data diagnostics - Basic graphical methods, graphical checks for overall adequacy of a model, deviance, cox-snell, martingale, and deviance residuals.

Books Recommended:
1. Sinha, S.K. (1980): Reliability and life testing, Wiley, Eastern Ltd.
2. Nelson, W. (1989): Accelerated Testing, Wiley.
3. Zacks, S.O.: Introduction to reliability analysis, probability models and statistical,SpringerVerlag.
4. Klein, J.P. and Moeschberger, M.L. (2003): Survival Analysis, technique for censored and truncated data, Springer.
5. Tableman, M. and Kim, J.S. (2004): Survival Analysis Using S, Chapman & Hall/CRC.
6. Lawless J.F. (2003): Models and Methods for life time data, Second edition, Wiley.
7. Collett (2014): Modeling Survival data in medical Research, Third edition, Chapman &Hall/CRC.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		

Course Code: **-B061007T**	Course Title: **Linear Models & Regression Analysis**
Credits: **04**	Core: **Elective Optional**
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36 with minimum 27 in End Exam**

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

Course Outcome:

The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:

After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
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6. Understand the

Detailed Syllabus

Unit-1

Linear Estimation: Gauss-Markov linear Models, Estimable functions, Error and Estimation Spaces, Best Linear Unbiased Estimator (BLUE), Least square estimator, Normal equations, Gauss-Markov theorem, generalized inverse of matrix and solution of Normal equations, variance and covariance of Least square estimators.

Unit-2

Test of Linear Hypothesis: One way and two way classifications. Fixed, random and mixed effect models . (two way classifications only), variance components.

Unit-3

Linear Regression: Bivariate, Multiple and polynomials regression and use of orthogonal polynomials, Residuals and their plots as tests for departure from assumptions of fitness of the model normality, homogeneity of variance and detection of outlines. Remedies.

Unit-4

Non Linear Models: Multi-collinearity, Ridge regression and principal components regression, subset selection of explanatory variables, Mallon's Cp Statistics.

Books Recommended:

1. Goon, A.M., Gupta, M.K. and Das gupta, B. (1987): An Outline of Statistical Theory, Vol.2, The World Press Pvt. Ltd .Culcutta.
2. Rao, C.R. (1973): Introduction to Statistical Infererence and its Applications, WileyEastern.
3. Graybill, F.A. (1961): An introduction to linear Statistical Models, Vol. 1, McGraw Hill Book Co. Inc.
4. Draper, N.R. and Smith, H (1998): Applied regression Analysis, 3rd Ed.Wiley.
5. Weisberg,S.(1985):Applied linear regression, Wiley.
6. Cook, R.D. and Weisberg, S.(1982): Residual and Inference in regression, Chapman &Hall.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: STATISTICS		
Course Code: -**B061008T**	Course Title: **Research Methodology**	
Credits: **04**	Core: Elective Optional	
Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: **36** with **minimum 27 in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**.		

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit-1
Importance of research methodology in statistical Reasearch: Motivation objectives and the porpose of the research. Types of Statistical research : Empirical , field experiments, Laboratory experiment. Primary and secondary source of data. Planned and adhoc methods of data collection. Non response and methods of recovering the missing response.

Unit-2
Generating data from standard univariate (discrete and continuous)Distributions and multivariate normal distribution. Exploring univariate and multivariate data using tables and plots.

Unit-3
Resampling techinques such that Bootstrap and Jackknife, Bootstrap Variance Estimation, Bootstrap (Interval and testing)

Unit-4
Simulation methods: Monte Carlo methods, techniques of Handling missing data, Imputation methods.

Unit-5
Reading research papers, reporting and thesis writing: structure and components of scientific reports. Types of reports: Technical reports and thesis: significance : different steps in the preprations: layout structure and language of typical reports. Illustrations and tables : Bibliography, referencing and footnots: oral presentations: planning: prepration: practice: making presentation, ethical issues: commercialisation: copyright Royalty. Intellual property Rights.

Book Recommended
1. Casella, George, and C. Robert. "Monte Carlo statistical methods." *University of Florida* (2008).
2. Coley, Soraya M., and Cynthia A. Scheinberg. *Proposal writing: Effective grantsmanship*. Sage, 2008.
3. Dey R. A. How to write and publish a scientific paper, Cambridge University Press(1992).
4. Efron, Bradley, and Robert J. Tibshirani. *An introduction to the bootstrap*. CRC press, 1994.
5. Coburn, Timothy C. "J. de Gruijter, D. Brus, M. Bierkens, and M. Knotters: Sampling for Natural Resource Monitoring." *Mathematical Geosciences* 40.3 (2008): 349.
6. Kothari, Chakravanti Rajagopalachari. *Research methodology: Methods and techniques*. New Age International, 2004.

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**

Subject: STATISTICS

Course Code: -**B061009T**	Course Title: **Marketing Research Statistics**

Credits: **04**	Core: **Elective Optional**

Max. Marks: **25 (CIE) + 75 (End Exam)**	Min. Marks: 36 with **minimum 27 in End Exam**

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

Course Outcome:
The main objective of this course is to learn concepts of real numbers and matrices applicable in the fie;d of Statistics.

Course Specific Outcomes:
After successful completion of this course, student will be able to:
1. Understand the role of real numbers
2. Learn about various approaches
3. Learn about the methods of
4. Learn about the applications of
5. Understand the
6. Understand the

Detailed Syllabus

Unit 1
Nature, Scope and Importance of Marketing, Approaches to the Study of Marketing, Changing Concepts of Marketing, Recent Innovations in Modern Marketing, Marketing Environment and Marketing System. Consumer Decision Behaviour, Consumer Buying Decision Pocess, Theory of Consumer Behaviour, Marketing Segmentation and Marketing Mix, Physical Distribution of Goods, Meaning and Objectives of Advertisement, Characteristics of an Effective Advertisement, Different Media of Advertisement, Choice of Advertising Media, Advertising Budget, Measuring the Effectiveness of Advertising.

Unit 2
Meaning and Nature of Marketing Research, Objective and Functions of Marketing Research, Elements of Marketing Research, Advantages and Limitations of Marketing Research, Process of Marketing Research, Marketing Research Design, Marketing Information System, Sampling Plan for Marketing Surveys.

Unit 3
Introduction to the Theory and Models in Marketing, Science and Marketing Models, Complexity of Marketing Models, Decision Support Models, Theoretical Modeling in Marketing, Purchase Incidence Models, Stochastic Models of Brand Choice.

Unit 4
Introduction to Advertisement and New Product Planning, The Effects of Advertising, Objective Setting and Budgeting—Practice and Models, Media Selection and Scheduling–Modelling Approaches, New Product Planning—Types of New Product Situations, Adoption Process for New Products, Models of First Purchase, repeat Purchase Models of New Products.

Unit 5
Brand Preference Index, Stability Index Based on Duration of Use, Stability Index Based on Quantity Ratio and Duration of Use, Brand Awareness Index, Consumer Satisfaction Measure, etc.

Books Recommended :

1. Statistical Process Control with six Sigma – M Ahmad, R Patawa, B Singh, A Jain
2. Marketing Models—Gary L. Lilien, Philip Kotler and K. Sridhar Moorthy

3. Marketing Management—C.B. Gupta
4. Marketing Analysis and Decision Making : Text and Cases—G.C. Darral
5. Advertising Management—A.A. David and J.G. Myers

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B061010P**	Course Title: **Practical**	
Credits: **04**	Core: **Compulsory**	
Max. Marks: **100 (End Exam)**	Min. Marks: **36 minimum in End Exam**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-8**.		

Detailed Syllabus

Practical Excersices based on all the Theory papers of Tenth Semester

Question Paper Pattern

Semester or External or End Term Assessment:

Format for Theory Paper: 75 Marks

Time : 03 Hours   Max. Marks : 75

Note :— Attempt all questions from Section–A and any 5 questions from Sections –B and 2 questions from section –C

Section– A (खण्ड–अ)
अंक विभाजन   2 × 10 = 20

1— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
2— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
3— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
4— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
5— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
6— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
7— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
8— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
9— Very Short answer type question
   अति लघु उत्तरीय प्रश्न
10— Very Short answer type question
   अति लघु उत्तरीय प्रश्न

Section–B (खण्ड–ब)
अंक विभाजन   5 × 5 = 25

1— Short answer type question
   लघु उत्तरीय प्रश्न
2— Short answer type question
   लघु उत्तरीय प्रश्न
3— Short answer type question
   लघु उत्तरीय प्रश्न
4— Short answer type question
   लघु उत्तरीय प्रश्न
5— Short answer type question
   लघु उत्तरीय प्रश्न
6— Short answer type question
   लघु उत्तरीय प्रश्न
7— Short answer type question
   लघु उत्तरीय प्रश्न
8— Short answer type question
   लघु उत्तरीय प्रश्न

Section–C (खण्ड–स)
अंक विभाजन   15 × 2 = 30

1— Long / Essay type question
2— Long / Essay type question
3— Long / Essay type question
4— Long / Essay type question