CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

STATISTICS

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN STATISTICS

SESSION 2025-2026 ONWARDS

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

Minutes of the Board of Studies (BoS) Meeting in Statistics

Date: 4th June 2025

Time: 11:30 AM (IST)

Mode: Online

Members Present:

- Dr. Vishwas Tiwari, Convener, BoS, Dept. of Statistics, D. A-V. College Kanpur.
- Prof. Himanshu Pandey, Dept. of Statistics, D.D.U. University Gorakhpur. (Subject Expert)
- Prof. Abhay Kumar Tiwari, Dept. of Statistics, B. H. U. Varanasi. (Subject Expert)
- Prof. Madhulika Dube, Dept. of Statistics, B.B.A. University Lucknow. (Subject Expert)
- Dr. R. B. Tiwari, Dept. of Statistics, D. A-V. College Kanpur (Internal Member)
- Dr. Nidhi Nagar Saxena, Dept. of Statistics, D. A-V. College Kanpur.(Internal Member)
- Dr. V. K. Jaiswal, Dept. of Statistics, P. P. N. College Kanpur. (Internal Member)
- Dr. A. K. Shukla, Dept. of Statistics, D. A-V. College Kanpur. (Special Invitees)

Agenda-wise Proceedings:

Item 1: Discussion and Finalization of the Four-Year Undergraduate Programme (FYUP) in Statistics (2025–26 onwards)

The committee discussed in detail the proposed curriculum structure of the FYUP under the NEP 2020 framework.

Members reviewed the credit distribution across semesters, course categories and progression path from Certificate to Honours with Research.

A detailed review was conducted of the course content and specific learning outcomes for each paper. Suggestions were made particularly for the 8th semester papers in Advanced Experimental Designs and Advanced Methods in Survey Sampling by **Prof. Abhay Kumar Tiwari**, leading to modifications in certain units as reflected in the revised review forms. These changes aim to enhance conceptual clarity and applicability in advanced topics.

Prof. Madhulika Dube suggested a revised title for the paper in the 7^{th} semester and recommended certain changes in the References section under Suggested Readings. She also pointed out a few internal inconsistencies and errors within the syllabus content that require correction.

Prof. Himanshu Pandey proposed some techniques and strategies to ensure the smooth implementation and effective functioning of the **FYUP** programme.

Assessment methods (internal assessments, theory examinations, project work) were finalized in alignment with UGC guidelines.

All the members of the Board of Studies appreciated the structure and contents of the FYUP programme. All the suggestions have been duly incorporated, and the revised syllabus has been unanimously approved by the Board of Studies.
Resolution: The proposed FYUP curriculum in Statistics for 2025–26 onwards was unanimously approved.

Item 2: Discussion and Approval of the Ph.D. Course Work Syllabus (2024–25 onwards)

The Ph.D. coursework syllabus, whose credit structure has already been adopted by the Academic Council, was presented to the Board for formal approval.
The syllabus includes two papers: Applied Regression Analysis and Forecasting and Advanced Multivariate Statistical Modeling. Students must choose only one paper from the subject-specific and one paper from the UGC-approved MOOC courses.
Resolution: The Board formally approved the Ph.D. Course Work Syllabus for 2024–25 onwards.

Item 3: Discussion on the Mandatory Involvement of Subject Experts from Statistics in All University Examination-Related Work

The committee addressed concerns regarding the inclusion of faculty from Mathematics in practical examinations and evaluation of Statistics courses over the past three years.
It was unanimously agreed that Statistics and Mathematics are two independent disciplines with distinct syllabi.
The Board emphasized the need for accuracy and subject integrity in all examination-related duties.
A resolution was proposed to ensure that paper setting, evaluation, practical examination, and scrutiny work for Statistics should be strictly handled by qualified experts in Statistics only.
The list of practical examiners must be revised with immediate effect to reflect this decision.
Resolution: The Board resolved to forward a formal recommendation to the University Examination Cell to ensure that only Statistics faculty members are appointed for examination-related work in Statistics, with immediate rectification of the current examiner lists.

Conclusion:

The meeting concluded with a vote of thanks to all members for their valuable inputs and active participation.

Prepared by:

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Prof. Himanshu Pandey

Prof. Abhay Kumar Tiwari

Prof. Madhulika Dube

Dr. R. B. Tiwari

Dr. Nidhi Nagar Saxena

Dr. V. K. Jaiswal

Dr. A. K. Shukla

National Education Policy-2020
Chhatrapati Shahu Ji Maharaj University Kanpur
B.Sc. , B. Sc.(Honours), B. Sc.(Honours with Research) and M. Sc. (1 Year) in Statistics
Course Structure and Syllabus under Four Year Undergraduate Program (FYUP)
SUBJECT: STATISTICS

Year	Sem	Course Code	Paper	Paper Title	Theory /Practical	Credits
1	I	B060101T	I	Descriptive Statistics (Univariate) and Theory of Probability	Theory	4
		B060102P	II	Descriptive Data Analysis Lab (Univariate)	Practical	2
	II	B060201T	I	Descriptive Statistics (Bivariate) and Probability Distributions	Theory	4
		B060202P	II	Descriptive Data Analysis Lab (Bivariate)	Practical	2
2	III	B060301T	I	Theory of Estimation and Sampling Survey	Theory	4
		B060302P	II	Sampling Survey Lab	Practical	2
	IV	B060401T	I	Testing of Hypothesis and Applied Statistics	Theory	4
		B060402P	II	Tests of Significance and Applied Statistics Lab	Practical	2
3	V	B060501T	I	Multivariate Analysis and Non- parametric Methods	Theory	4
		B060502T	II	Analysis of Variance and Design of Experiment	Theory	4
		B060503P	III	Non-parametric Methods and DOE Lab	Practical	2
	VI	B060601T	I	Statistical Computing and Introduction to Statistical Software	Theory	4
		B060602T	II	Operations Research	Theory	4
		B060603P	III	Operations Research and Statistical Computing Lab	Practical	2
		B. Sc. (Honours)				
4	VII	B060701TF	I	Linear Models	Theory	4
		B060702TF	II	Measure Theory and Probability	Theory	4
		B060703TF	III	Data Analysis Using R	Theory	4
		B060704TF	IV	Real Analysis	Theory	4
		B060705PF	V	Linear Models & Data Analysis Using R Lab	Practical	4
	VIII	B060801TF	I	Econometrics	Theory	4
		B060802TF	II	Advanced Experimental Designs	Theory	4
		B060803TF	III	Advanced Methods in Survey Sampling	Theory	4
		B060804TF	IV	Population Studies	Theory	4
		B060805PF	V	Econometrics, Experimental Techniques and Sampling Methods Lab	Practical	4

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

B. Sc. (Honours with Research) ***Research Project (VIIth & VIIIth Sem) will be given only to those students who obtain minimum of 75% marks till their sixth semester***						
4	**VII**	B060701TF	I	Linear Models	Theory	4
		B060702TF	II	Measure Theory and Probability	Theory	4
		B060703TF	III (any one elective)	Data Analysis Using R	Theory	4
		B060704TF		Real Analysis	Theory	4
		B060705PF	IV	Linear Models & Data Analysis Using R Lab	Practical	4
		B060706RF	V	Research Project/Dissertation	Project	4
	VIII	B060801TF	I	Econometrics	Theory	4
		B060802TF	II	Advanced Experimental Designs	Theory	4
		B060803TF	III (any one elective)	Advanced Methods in Survey Sampling	Theory	4
		B060804TF		Population Studies	Theory	4
		B060805PF	IV	Econometrics, Experimental Techniques and Sampling Methods Lab	Practical	
		B060806RF	V	Research Project/Dissertation	Project	4
M. Sc. Statistics (1 Year)						
5	**IX**	B060901TF	I	Statistical Inference	Theory	4
		B060902TF	II	Optimization Techniques	Theory	4
		B060903TF	III (any one elective)	Industrial Statistics	Theory	4
		B060904TF		Reliability Theory and Life Distributions		
		B060905PF	IV	Optimization Techniques, Statistical Inference, and Industrial Statistics Lab	Practical	4
		B060906RF	V	Research Project (Progressive)	Project	4
	X	B061001TF	I	Multivariate Analysis	Theory	4
		B061002TF	II	Stochastic Processes	Theory	4
		B061003TF	III (any one elective)	Biostatistics	Theory	4
		B061004TF		Actuarial Statistics		
		B061005PF	IV	Statistical Methods in Multivariate, Stochastic, and Applied Analysis Lab	Practical	4
		B061006RF	V	Research Project (Submitted)	Project	4

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

: Subject Prerequisites:

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

:: Programme Outcomes (POs) ::

Students having Degree in B.Sc., B.Sc. (Honours), B. Sc. (Honours with Research) M. Sc. in 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. (Honours), B. Sc. (Honours with Research) and M. Sc. in 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.
- Gain skills to conduct independent and collaborative statistical research, including designing experiments, surveys, and analyzing real-life data.
- Communicate statistical findings effectively through written reports, oral presentations, data visualizations, and graphical summaries.

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

: List of All Papers in All Eighth Semesters:

Programme	Year	Semester	Course Title		Credits	Teaching Hours
Certificate in Descriptive Statistics and Probability	I	First	Theory(B060101T) Descriptive Statistics (Univariate) 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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme	Year	Semester	Course Title	Credits	Teaching Hours
B.Sc. (Honours)	IV	Seventh	Theory-I(B060701TF): Linear Models	04	60
			Theory-II(B060702TF): Measure Theory and Probability	04	60
			Theory-III(B060703TF): Data Analysis Using R	04	60
			Theory-IV(B060704TF): Real Analysis	04	60
			Practical(B060705PF): Linear Models & Data Analysis Using R Lab	04	120
		Eighth	Theory-I(B060801TF): Econometrics	04	60
			Theory-II(B060802TF): Advanced Experimental Designs	04	60
			Theory-III(B060803TF): Advanced Methods in Survey Sampling	04	60
			Theory-IV(B060804TF): Population Studies	04	60
			Practical(B060805PF): Econometrics, Experimental Techniques and Sampling Methods Lab	04	120

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

Programme	Year	Semester	Course Title	Credits	Teaching Hours
B.Sc. (Honours with Research) Students who secure 75% marks in the first six semesters	**IV**	**Seventh**	**Theory-I(B060701TF) : Linear Models**	**04**	**60**
			Theory-II(B060702TF): Measure Theory and Probability	**04**	**60**
			Theory-III(B060703TF): Data Analysis Using R (ELECTIVE)	**04**	**60**
			Theory-IV(B060704TF) : Real Analysis (ELECTIVE)	**04**	**60**
			Practical(B060705PF): Linear Models & Data Analysis Using R Lab	**04**	**120**
			(B060706RF): Research Project/Dissertation	**04**	**60**
		Eighth	**Theory-I(B060801TF): Econometrics**	**04**	**60**
			Theory-II(B060802TF): Advanced Experimental Designs	**04**	**60**
			Theory-III(B060803TF) : Advanced Methods in Survey Sampling (ELECTIVE)	**04**	**60**
			Theory-IV(B060804TF): Population Studies (ELECTIVE)	**04**	**60**
			Practical(B060805PF): Econometrics, Experimental Techniques and Sampling Methods Lab	**04**	**120**
			(B060806RF): Research Project/Dissertation	**04**	**60**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme	Year	Course Title	Credits	Teaching Hours
Apprenticeship/Internship Embedded B. Sc. Degree	IV	**12 Months Apprenticeship/Internship through NATS or from equivalent organization / Industry/ Institute**	40	1200

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme	Year	Semester	Course Title	Credits	Teaching Hours
M.Sc. Statistics (I Year)	V	Ninth	Theory-I(B060901TF) : Statistical Inference	04	60
			Theory-II(B060902TF): Optimization Techniques	04	60
			Theory-III(B060903TF): Industrial Statistics (ELECTIVE)	04	60
			Theory-IV(B060904TF) : Reliability Theory and Life Distributions (ELECTIVE)	04	60
			Practical(B060905PF): Optimization Techniques, Statistical Inference and Industrial Statistics Lab	04	120
			(B060906RF): Research Project (Progressive)	04	60
		Tenth	Theory-I(B061001TF): Multivariate Analysis	04	60
			Theory-II(B061002TF): Stochastic Processes	04	60
			Theory-III(B061003TF): Biostatistics (ELECTIVE)	04	60
			Theory-IV(B061004TF): Actuarial Statistics (ELECTIVE)	04	60
			Practical(B061005PF): Statistical Methods in Multivariate, Stochastic and Applied Analysis Lab	04	120
			(B061006RF): Research Project (submitted)	04	60

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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 summarizing data sets, including common graphical tools (such as boxplots, histograms and stem plots). Interpret histograms and boxplots.
- ✓ Ability to describe data with measures of central tendency and measures of dispersion.
- ✓ Ability to understand measures of skewness and kurtosis and their utility and significance.
- ✓ Ability to understand the concept of probability along with basic laws and axioms of probability.
- ✓ Ability to understand the terms mutually exclusive and independence and their relevance.
- ✓ Ability to identify the appropriate method (i.e. union, intersection, conditional, etc.) for solving a problem.
- ✓ Ability to apply basic probability principles to solve real life problems.
- ✓ Ability to understand the concept of random variable (discrete and continuous), concept of probability distribution.

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

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

Unit	Topic	No. of Lectures
	Part-A: Descriptive Statistics (Univariate)	
I	Introduction to Statistics, Meaning of Statistics, Importance of Statistics, Scope of Statistics in Industry, Introduction and contribution of Indian Scholars in Statistics. Concept of Statistical population, Attributes and Variables (Discrete and Continuous), Different types of scales – Nominal, Ordinal, Ratio and Interval, Primary data – designing a questionnaire and schedule, collection of primary data, checking their consistency, Secondary data.	**06**
II	Presentation of data: Classification, Tabulation, Diagrammatic & Graphical Representation of Grouped data, Frequency distributions, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogives. Stem and Leaf plot, Box Plot.	**08**
III	Measures of Central tendency and Dispersion and their properties, Merits and Demerits of these Measures.	**10**
IV	Moments and Factorial moments, Shephard's correction for moments, Measures of Skewness and Kurtosis and their significance, Measures of skewness based on quartiles.	**06**

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

Part-B: Theory of Probability		
V	Random experiment, Trial, Sample point and Sample space, Events, Operations of events, Concept of equally likely, Mutually exclusive and Exhaustive events. Definition of Probability: Classical, Relative frequency and Axiomatic approaches.	**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**

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

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 Mathematical 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). Distributions 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
https://www.coursera.org/search?query=statistics&

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 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:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course a student will have:

- ✓ Ability to represent/summarise the data/information using appropriate Graphical methods including common graphical tools (such as boxplots, histograms and stemplots) and also to draw inferences from these graphs
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of central tendency as per the nature and need of the data and draw meaningful conclusions regarding behavior of the data.
- ✓ Acquire the knowledge to identify the situation to apply appropriate measure of dispersion as per the nature and need of the data and draw meaningful conclusions regarding heterogeneity of the data.
- ✓ Ability to measure skewness and kurtosis of data and define their significance.
- ✓ Acquire the knowledge to compute conditional probabilities based on Bayes Theorem.

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Suggested Continuous Evaluation Methods: (25 Marks)

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

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

Suggested equivalent online courses:
……..

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.
……..

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

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

& Presentation may be verbal or by using ppt etc.

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **Certificate**	Year: **First**	Semester: **Second**
Subject: **STATISTICS**		
Course Code: -**B060201T**	Course Title: **Descriptive Statistics (Bivariate) and Probability Distributions**	

Course outcomes:

After completing this course a student will have:

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Suggested Readings:

Part A:

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

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

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

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

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

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

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

Part B:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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&

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-IV (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

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

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course, a student will have:

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

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

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

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

Suggested Readings:

As suggested for paper code B060201T.

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

Open to ALL

Suggested Continuous Evaluation Methods:

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

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

e.g.

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

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

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

& Presentation may be verbal or by using ppt etc.

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course, a student will have:

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

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

Total No. of Lectures-Tutorials-Practical (in hours per week): **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. Problems and examples, Interval estimation.	**08**
IV	Method of Maximum Likelihood and properties of maximum likelihood estimators (without proof), Method of minimum Chi-square. Method of least squares and methods of moments for estimation of parameters	**09**

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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.

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

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

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course, a student will have:

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

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:
As suggested for paper code B060301T.

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

Suggested Continuous Evaluation Methods:

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

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

Suggested equivalent online courses:
……..

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.

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **Diploma**	Year: **Second**	Semester: **Fourth**
Subject: **STATISTICS**		
Course Code: **-B060401T**	Course Title: **Testing of Hypothesis and Applied Statistics**	

Course outcomes:

After completing this course a student will have:

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

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

Total No. of Lectures-Tutorials-Practical (in hours per week): **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), 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) $\rho = \rho_0$ (b) $\rho_1 = \rho_2$,	**10**
IV	Small sample tests based on t, f and chi-square distributions.	**04**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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, 3σ control limits, Principle underlying the construction of control charts. Control charts for variables, '$\bar{X}$' and 'R' charts, construction and interpretation, Control charts for attributes 'p' and 'c' charts, construction and interpretation	**06**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Part A

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Part B

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

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

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

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

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&

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

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

Suggested equivalent online courses:

Further Suggestions:

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course a student will have:

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

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:
As suggested for paper code B060401T.

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

Suggested Continuous Evaluation Methods:

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

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

Suggested equivalent online courses:
……..

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course, a student will have:

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

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

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

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 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:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course, a student will have:

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

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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. (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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 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:

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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.
4. Ability to perform ANOVA for one way and two classifications.
5. Ability to perform post-hoc analysis.
6. Ability to conduct analysis of CRD, RBD and LSD with and without missing observations.
7. Ability to conduct analysis for Factorial experiments (without confounding).

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

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

Suggested Continuous Evaluation Methods:

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

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

Suggested equivalent online courses:
……..

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

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course a student will have:

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 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:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course a student will have:

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 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:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

Course outcomes:

After completing this course a student will have:

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

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

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

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

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

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

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

Suggested Continuous Evaluation Methods:

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

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

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

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

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **-B060701TF**	Course Title: **Linear Models**	

Course outcomes:

After completing this course, a student will be able to:

- ✓ Use the definitions of vector space and related things and determine the orthonormal basis
- ✓ Understand the linear transformation and its matrix representation
- ✓ Have awareness of Matrix theory concepts that can be used further in Multivariate Analysis and Designs of Experiments
- ✓ To understand the scientific value of the traditional knowledge of India

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

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

Unit	Topic	No. of Lectures
I	Contribution of Indian Knowledge System to the development of Statistical Thought. Historical development and indigenous approaches to data analysis and quantitative reasoning.	**04**
II	Finite dimensional vector spaces, Existence of basis, Orthogonal matrices. Gram-Schmidt orthogonalisation method.	**08**
III	Algebra of matrices, Rank of a matrix, Inverse of a matrix and its properties.	**06**
IV	Linear transformations, Matrix representation of linear transformations, Solution of linear equations using matrices.	**06**
V	Generalized inverse of a matrix, Elementary properties of generalized inverses.	**06**
VI	Characteristic roots and vectors of a matrix, Cayley-Hamilton Theorem, Idempotent matrices.,	**08**
VII	Real quadratic forms, Definiteness of a real quadratic form, Reduction and classification of quadratic forms.	**08**
VIII	Linear estimations: Linear models with assumptions on error components, Estimable functions and error spaces, Best Linear Unbiased Estimator (BLUE), Testing of general linear hypothesis under normality of errors.	**14**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Bapat, R. B. (2012) Linear Algebra and Linear Models, Springer-Verlag, London

Rao, C. R. (1973). *Linear statistical inference and its applications* (Vol. 2, pp. 263-270). New York: Wiley.

Biswas, S. (2012). *Textbook of Matrix Algebra*. PHI Learning Pvt. Ltd.

Searle, S.R. Linear Models (Wiley)

Searle, S.R. (1982) Matrix Algebra useful for Statistics (Wiley)

Harville, D.A., Matrix Algebra from a Statistician's Perspective; Springer

Graybill FA (1983). Matrices with applications in Statistics. 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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-Iii (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……

Further Suggestions:

……

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **-B060702TF**	Course Title: **Measure Theory and Probability**	

Course outcomes:

After completing this course, a students will be able to:

- ✓ Understand sigma-fields, Borel fields, and basic set functions in probability theory.
- ✓ Apply probability measures, Lebesgue and Lebesgue-Stieltjes measures.
- ✓ Interpret random variables as measurable functions and use convergence theorems.
- ✓ Distinguish and relate different modes of convergence for random variables.
- ✓ Apply laws of large numbers, central limit theorems, and characteristic functions.

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

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

Unit	Topic	No. of Lectures
I	Sets and classes of sets, Fields and sigma-fields, Minimal sigma-field and Borel sigma-field, Sequence of sets, Monotone classes of sets	**07**
II	Set functions and continuity of set functions, Measure function and its properties, Probability measure and probability space	**08**
III	Lebesgue measure, Lebesgue-Stieltjes measure and its properties, Caratheodory Extension Theorem (statement only)	**08**
IV	Measurable functions, Random variable as a measurable function, Sequences of measurable functions and random variables, Monotone Convergence Theorem	**08**
V	Convergence of sequences of random variables: In distribution, In probability, In rth mean, Almost everywhere. Criteria and inter-relations among the modes of convergence, Helly-Bray Theorem (statement only)	08
VI	Borel-Cantelli Lemma, Borel 0-1 Law, Khintchine's Weak Law of Large Numbers, Khintchine's Strong Law of Large Numbers, Kolmogorov's Theorems	07
VII	Central Limit Theorem (CLT): Lindeberg-Levy Theorem, Laplace-Liapunoff Theorem, Lindeberg-Feller Theorem (statement only)	**07**
VIII	Characteristic functions, Uniqueness theorem for characteristic functions, Inversion theorem	**07**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Feller W. (2008) An Introduction to Probability Theory and its Applications, Vol II, Second edition, Wiley India (P) Ltd. Billingsley P (2008): Probability and Measure, Third edition, Wiley India Pvt. Ltd.
Halmos, P. R. (2013). Measure theory (Vol. 18). Springer.
Kubrusly, C. S. (2015). Essentials of measure theory. Springer International Publishing.
Doob, J. L. (2012). Measure theory (Vol. 143). Springer Science & Business Media.
Bhat, B. R. (2007). Modern probability theory. New Age International.
Ash, R. B., Robert, B., Doleans-Dade, C. A., & Catherine, A. (2000). Probability and measure theory. Academic press.
Loeve, M. (2017). Probability theory. Courier Dover Publications.
Chow, Y. S., & Teicher, H. (2003). Probability theory: independence, interchangeability, martingales. Springer Science & Business Media.
Rohtagi V.K. and Saleh A.K. Md E (2008) An introduction to Probability Theory and Mathematical Statistics. John Wiley & Sons, New York

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc. (Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **-B060703TF**	Course Title: **Data Analysis Using R**	

Course outcomes:

After completing this course, a student will be able to:

- ✓ Understand how to use the command and syntax of R for statistical calculations
- ✓ Understand the applicability of the statistical tools as per the data and other analytical requirements
- ✓ Apply statistical techniques on real life complex statistical data

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

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

Unit	Topic	No. of Lectures
I	Introduction to statistical software, Installation procedure, Overview of R and RStudio, Understanding packages and the library in R	**06**
II	Basic file operations, Data objects in R, Creating and manipulating vectors, Creating matrices	**08**
III	Accessing elements of vectors and matrices, Lists: creation and manipulation, Data frames: creation and manipulation, Importing files into R, Boolean operators	**09**
IV	If command and if-else command, Looping structures: for loop, while loop, repeat loop, Functions in R, Scoping rules in functions	**07**
V	Manipulating vectors, matrices, lists, Computation of descriptive statistics for univariate data, Construction of frequency tables	**07**
VI	Techniques for handling and analyzing bivariate data, Use of functions and structures to summarize relationships	**05**
VII	Creating histograms and box-plots, Stem-and-leaf plots, Scatter plots for bivariate data	**09**
VIII	Plotting probability distributions, Plotting sampling distributions, Simulation techniques and applications in R	**09**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Wickham, H. (2008). A First Course in Statistical Programming with R. Journal of Statistical Software, 28, 1-3.
Purohit S.G., Gore,S.D. and Deshmukh,S.R.(2008) Statistics Using R, Alpha Science
W. John Braun and D. J. Murdoch (2007); A Frist Course in statistical programming with R parametric inference. Cambridge University Press.
Alain F. Zuur, Elena N. Ieno, and Erik Meesters, "A Beginner's Guide to R", Springer, 2009, ISBN:978-0-387-93836-3.
W Michael J. Crawley, "Statistics: An Introduction using R", Wiley, 2005, ISBN 0-470-02297-3.
Phil Spector, "Data Manipulation with R", Springer, New York, 2008, ISBN 978-0-387-74730-9.
Maria L. Rizzo, "Statistical computing with R", Chapman & Hall/CRC, Boca Raton, FL, 2008, ISBN 1-584-88545-9.
W. John Braun and Duncan J. Murdoch, "A first course in Statistical programming with R", Cambridge University Press, Cambridge, 2007, ISBN 978-0521872652.
Hothorn,T and Everitt, B.S.(2014). A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC Press, Boca Raton, Florida, USA, 3rd edition.
Knell, R.J. (2013), Introductory R: A Beginner's Guide to Data Visualisation and Analysis using R.
Kundu, D. and Basu, A. (2004) Statistical computing – existing methods and recent developments, Narosa
publishing house, New Delhi
Monahan, J.F. (2001) Numerical methods of statistics, Cambridge University Press.
Tattar Prabhanjan and Ramaiah, S. and Manjunath, B.G. A Course in Statistics with R, 1st Edition, Wiley
Lander J. P. (2014). R for Everyone: Advanced Analytics and Graphics, Pearson

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc. (Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: **-B060704TF**	Course Title: **Real Analysis**	

Course outcomes:

After completing this course, a student will able to:

- ✓ Understand continuity, uniform continuity, and differentiability of real functions.
- ✓ Apply Mean Value Theorems and Taylor series for analysis and approximation.
- ✓ Analyze multivariable functions and solve optimization problems using Lagrange multipliers.
- ✓ Evaluate definite and improper integrals and test for convergence.
- ✓ Compute double/triple integrals and apply change of variables using Jacobians.

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

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

Unit	Topic	No. of Lectures
I	Real-valued functions of one variable, Concept of continuity, Continuity in intervals, Properties of continuous functions, Uniform continuity and its implications	**06**
II	Differentiability of functions of one variable, Relationship between continuity and differentiability, Mean Value Theorem (Rolle's and Lagrange's forms), Applications of the Mean Value Theorem	**07**
III	Taylor's and Maclaurin's series for one-variable functions, Remainder terms and error estimation, Applications of Taylor expansions to approximations	**06**
IV	Functions of several variables: definitions and examples, Concept of maxima and minima, Method of Lagrange multipliers for constrained optimization, Geometrical interpretation and examples	**08**
V	Fundamental Theorem of Calculus, Mean Value Theorem for definite integrals, Applications in computation and analysis	06
VI	Definition and classification of improper integrals, Convergence of infinite integrals, Comparison test, ratio test, and other standard convergence tests, Uniform convergence of improper integrals	**08**
VII	Leibniz's Rule for differentiation under the integral, Conditions for validity, Applications and illustrative examples	**06**
VIII	Double and triple integrals, Evaluation by repeated integration, Change of variables in multiple integrals (Jacobian technique), Dirichlet's integral and its applications	**13**

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Apostol, T. M. (1965). A Course in Mathematical Analysis, Vol. II.
Dudley, R. M. (2018). *Real analysis and probability*. CRC Press.
Rudin, W. (1976). *Principles of mathematical analysis* (Vol. 3). New York: McGraw-hill.
Bartle R G and Sherbert D R (2011), Introduction to Real Analysis, Wiley India Edition
Kumar A and Kumaresan S (2014). A Basic Course in Real Analysis, CRC Press

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Seventh**
Subject: **STATISTICS**		
Course Code: - **B060705PF**	Course Title: **Linear Models & Data Analysis Using R Lab**	

Course outcomes:

After completing this course, a student will be able to:

1. Solve linear equations using matrix operations.
2. Apply orthogonalization and vector space concepts.
3. Analyse matrices using eigenvalues and theorems.
4. Evaluate and reduce quadratic forms.
5. Build and interpret linear models.
6. Perform data cleaning and analysis in R.
7. Develop R programs for statistics and simulation

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

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

	Topic	No. of Lectures
	1.Problems based on Rank, inverse, generalized inverse, and solving linear equations 2.Problems based on Basis, orthogonal matrices, Gram-Schmidt process 3.Problems based on Characteristic roots and vectors, Cayley-Hamilton theorem, idempotent matrices 4.Problems based on Quadratic Forms Analysis 5.Problems based on Linear Models and Estimation 6. Problems based on Data Import and Cleaning in R 7.Problems based on Descriptive Statistics and Frequency Tables using R 8. Problems based on Data Visualization and Graph Plotting in R 9. Problems based on Control Structures and Function Development in R 10. Problems based on Simulation and Probability Distributions with R	**120**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:
As suggested for paper code B060701TF and B060703TF.

Suggested Continuous Evaluation Methods:

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

Practical File/Record	**(05 marks)**
Assignment based on B060701TF/ B060702TF/ B060703TF/ B060704TF	**(05 marks)**
Case Study based on B060701TF/ B060702TF/ B060703TF/ B060704TF	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

Course prerequisites: To study this course, a student must have opted/passed the **paper code B060701TF/ B060703TF.**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: **-B060801TF**	Course Title: **Econometrics**	

Course outcomes:

After completing this course, a student will have:

- ✓ Understand various econometric models, estimation methods and related econometric theories
- ✓ Have deeper understanding of assumptions, estimation and testing of hypothesis in regression models
- ✓ Be able to describe the effects of violation of assumptions of classical model and apply appropriate alternative models
- ✓ Develop regression models and understand estimation procedures for simultaneous equation models

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

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

Unit	Topic	No. of Lectures
I	Introduction to Econometrics, Nature and scope of Econometrics, Assumptions and structure of the General Linear Model (GLM), Ordinary Least Squares Estimation (OLSE), Properties of OLSE, Prediction using GLM	07
II	Assumptions and formulation of GLS, Estimation and properties of GLS estimators, Comparison of GLS and OLSE, Prediction using GLS, Application scenarios where GLS is appropriate	**06**
III	Inference in Linear Models: Test of significance for parameters, Construction of confidence intervals, Use and construction of orthogonal polynomials in regression, Application of orthogonal polynomials for model simplification	06
IV	Heteroscedasticity and Its Remedies: Nature and sources of heteroscedasticity, Consequences for OLSE, Detection methods (e.g., graphical analysis, statistical tests), Transformations and Weighted Least Squares (WLS), Heteroscedasticity-consistent standard errors	**07**
V	Autocorrelation and Multicollinearity: Nature and consequences of autocorrelation, Detection: Durbin-Watson test, graphical analysis, Remedies for autocorrelation, Nature, detection, and consequences of multicollinearity, Ridge regression as a remedy	08
VI	Dynamic Models: Autoregressive linear regression models, Estimation techniques in lag models, Applications in time-series analysis	**08**

Dr. Vishwas Tiwari
Convener (Statistics)
C.S.J.M. University, Kanpur

VII	Introduction to non-linear models, intrinsically non-linear models and their characteristics, Linearization using Taylor's series, Estimation of structural parameters, Challenges and examples of non-linear regression	07
VIII	Structure and examples of simultaneous linear equation models, Identification problems and rank-order conditions, Imposing restrictions on structural parameters, Estimation techniques: Indirect Least Squares (ILS), Two-Stage Least Squares (2SLS), Overview of Limited Information Maximum Likelihood (LIML) and Full Information Maximum Likelihood (FIML) estimators	**11**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Koutsoyiannis, A. (1975). Modern microeconomics. Springer.

Johnston, J., & DiNardo, J. (1963). Econometric methods (Vol. 17). New York.

Amemiya, T. (1973). Nonlinear Methods in Econometrics.

Gujarati, D. N. (2011). Econometrics by example (Vol. 1). New York: Palgrave Macmillan.

Gujarati, D. N. (2021). Essentials of econometrics. SAGE Publications.

Dadkhah, K. M. (1984). Introduction to the Theory and Practice of Econometrics.

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: **-B060802TF**	Course Title: **Advanced Experimental Designs**	

Course outcomes:

After completing this course, a student will be able:

- ✓ Apply ANOVA techniques for one-way and two-way classifications.
- ✓ Handle missing data and implement split-plot designs.
- ✓ Analyze block designs and interpret information matrices.
- ✓ Evaluate design efficiency using optimality criteria.
- ✓ Construct and analyze BIBD and PBIBD.
- ✓ Use Latin and Graeco-Latin square designs effectively.
- ✓ Design and analyze simple and triple lattice designs.
- ✓ Conduct factorial experiments and interpret main/interaction effects.

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

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

Unit	Topic	No. of Lectures
I	Review: Fundamentals of Analysis of Variance (ANOVA) and Its Components, One-way and two-way classification, Fixed effects vs random effects models, Assumptions and structure of two-way ANOVA, Interpretation and computation of F-statistics	**08**
II	Designs with Missing Data: Handling missing plots in experimental designs, Methods for estimating missing values, Concept and application of Split Plot Design, Examples from agricultural and industrial experiments	**07**
III	Definition and types of block designs, Layout and analysis of general block design, Construction of information matrix, Properties and interpretation of the information matrix	**07**
IV	Criteria for Design Efficiency: Connectedness and its implications, Orthonormality and its significance in design, Efficiency criteria for comparing experimental designs, Design optimality: A-, D-, E-criteria	**06**
V	Balanced and Partially Balanced Incomplete Block Designs: Concepts and construction of BIBD and PBIBD, Parameters and conditions for existence, Analysis of BIBD and PBIBD, Applications in experimental setups	**08**
VI	Extension of block designs to row-column designs, Latin square and Graeco-Latin square designs, Recovery of intra- and inter-block information, Use of adjusted treatment means in analysis	**07**
VII	Introduction to Lattice designs: Simple and Triple Lattice, Relationship to BIBDs, Layout, analysis, and applications, Advantages over other incomplete block designs	**08**
VIII	Concept of factorial experiments: 2^n and 3^n designs, Main and interaction effects, orthogonality, Best linear unbiased estimates and significance tests, Complete and partial confounding, Fractional replication and resolution in symmetric factorials	**09**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Montgomery, D. C. (2017). *Design and analysis of experiments*. John wiley & sons.
Angela Dean & Daniel Voss (2006). Design and Analysis of Experiments, Springer
Verlag Campbell M.J, Machin D. & Walters S.J (2007). Medical Statistics – A Text Book for the Health Sciences, Wiley.
Cochran & Cox (2000). Experimental Designs, Wiley Asia
Das M.N. & Giri N.C. (2006). Design and Analysis of Experiments, New Age Publications
Hinkelmann, K., & Kempthorne, O. (2007). *Design and analysis of experiments, volume 1: Introduction to experimental design* (Vol. 1). John Wiley & Sons.
Joshi, D. D., & Joshi, D. D. (1987). *Linear estimation and design of experiments*. New Age International.
Casella, G., Fienberg, S., & Olkin, I. (2008). *Statistical design* (pp. 32611-38545). New York: Springer.
John, P. W. (1998). *Statistical design and analysis of experiments*. Society for Industrial and Applied Mathematics.
Giri, N. C. (1979). *Design and analysis of experiments*. New Age International.
Friedman IM Furberg CD Demets DL. Fundamentals of clinical trials. 4th edition. Springer. 2010.
Meinert CL. Clinical trials: Design conduct and analysis. 2nd edition. New York: Oxford University Press. 2012.
Pocock S. Clinical trials – A practical approach. John Wiley & Sons. 2010.
Campbell DT Shadish WR Cook TD. Experimental and quasi experimental designs for generalized causal inference. New York: Houghton Mifflin. 2002

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-IV (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: **-B060803TF**	Course Title: **Advanced Methods in Survey Sampling**	

Course outcomes:

After completing this course, a student will :

- ✓ Understand basic concepts of sampling and distinguish between fixed-population and super-population approaches.
- ✓ Apply SRS, Systematic, and Stratified Sampling methods in survey design.
- ✓ Use ratio and regression estimators with auxiliary information for improved estimation.
- ✓ Evaluate cluster sampling methods and compare them with SRS.
- ✓ Implement two-stage and multistage sampling techniques.
- ✓ Apply PPS sampling methods with and without replacement.
- ✓ Use unequal probability estimators like Desraj's, Murthy's, and Horvitz-Thompson.
- ✓ Identify sampling and non-sampling errors and apply error-reduction techniques.

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

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

Unit	Topic	No. of Lectures
I	Review of Introduction to Sampling Theory: Fixed-population and super-population approaches, Complete enumeration vs. sampling, Basic concepts in sampling, Distinctive features of finite population sampling	06
II	Overview of probability sampling methods, Simple Random Sampling (SRS), Systematic Sampling, Stratified Sampling, Key characteristics and applications	**08**
III	Use of auxiliary variables in estimation, Ratio method of estimation, Regression method of estimation, Properties and efficiency of ratio and regression estimators	07
IV	Cluster Sampling Techniques: Equal size cluster sampling, Estimators of population mean and total in cluster sampling, Standard errors of cluster estimators, Comparison with SRS using intra-class correlation coefficient	**07**
V	Two-stage sampling with equal number of second-stage units, Estimation of population mean and total, Concept and need for multistage sampling, Practical applications and advantages	**08**
VI	Sampling with Probability Proportional to Size (PPS), With replacement, Without replacement, Cumulative sum method, Lahiri's method	**08**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

VII	Estimators in Unequal Probability Sampling: Ordered estimator: Desraj's estimator, Unordered estimator: Murthy's estimator for sample size 2, Horvitz-Thompson estimator and its properties	**08**
VIII	Sampling and non-sampling errors, Types and sources of non-sampling errors, Incomplete surveys and Hansen-Hurwitz technique, Randomised response technique: Warner's method, Observational errors and mitigation strategies	**08**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Nassiuma, D. K. (2001). Survey sampling: Theory and methods.

Wu, C., & Thompson, M. E. (2020). Sampling theory and practice. Cham: Springer International Publishing.

Chaudhuri, A., & Stenger, H. (2005). Survey sampling: theory and methods. CRC Press.

Mukhopadhyay, P. (2008). Theory and methods of survey sampling. PHI Learning Pvt. Ltd.

Cochran, W.G. (2002). Sampling Techniques. Wiley

Des Raj and Chandhok (1998). Sampling Theory, Narosa.

Murthy, M.N. (1967). Sampling Theory and Methods. Statistical Publishing Company, Calcutta.

Sukhatme, P.V., Sukhatme B.V., Sukhatme S. and Asok C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press

Cochran, W.G. (2002). Sampling Techniques. Wiley

Sampath S.(2005). Sampling Theory and Methods. Narosa Publishing House

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……

Further Suggestions:

……

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: **-B060804TF**	Course Title: **Population Studies**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand and assess key sources of demographic data.
- ✓ Apply basic demographic methods and calculate vital rates.
- ✓ Construct and interpret life tables.
- ✓ Analyze population growth and make projections.
- ✓ Use indirect methods to estimate demographic indicators.
- ✓ Evaluate the quality of data from surveys and registration systems.
- ✓ Examine fertility and nuptiality patterns.
- ✓ Understand trends in urbanization and migration.

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

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

Unit	Topic	No. of Lectures
I	Sources of Demographic Data: Demographic data from census, civil registration, NSS and other surveys, Nature, limitations, and uses of demographic data, Introduction to demographic methods	**06**
II	Definitions and construction of vital rates and ratios, Crude Birth Rate (CBR), Crude Death Rate (CDR), Age-Specific Rates, Mortality rate and Standardized Death Rate (SDR)	**08**
III	Life Tables: Concepts of complete and abridged life tables, Construction of life tables using vital statistics and census returns, Uses and applications of life tables in demography	**08**
IV	Population Growth and Projections: Logistic and other population growth curves, Fitting logistic curves to demographic data, Population projections: concepts and techniques, Stable and quasi-stable population models	**08**
V	Techniques for estimation of demographic parameters, Use of indirect estimation methods, Application in the absence of complete data	06
VI	Registration and Survey Systems: Civil Registration System (CRS), Sample Registration System (SRS), National Sample Survey (NSS), National Family Health Survey (NFHS), District Level Household Surveys (DLHS), Reproductive and Child Health Survey (RCHS), Nature, quality, and limitations of data from these sources	**06**
VII	Nuptiality in Indian and international contexts, Measures of nuptiality, Concepts: natural fertility, fertility, fecundity, fecundability, Measures of fertility and reproduction, Cohort vs. period fertility, Sources of fertility data	**09**
VIII	Urbanization and Migration: Patterns of world and Indian urbanization, Components of urban growth, mega cities, and their implications, Definitions and types of migration, Migration trends and demographic diversity	**09**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Pressat R. & Atherton A. (1972). Demographic Analysis.
Preston S.H.,Heuveline P. & Guillot M. Demography-Measuring and Modelling Population Processes.
Deshpande, J.V. and Purohit,S.G.(2005) Life Time Data: Statistical Models And Methods,World Scientific
Samuel H. Preston Patrick Henveline and Michel Guillot (2001) Demography: Measuring and Modeling, Blackwell Publisher.
Nathan Keyfitz (1968) Introduction to the Mathematics of Population Addison –Wesley Publishing Company Reading Massachusettes
Jacob S. Siegel and David a. Swanson (2004): The Methods and Materials of Demography Second Edition Chapters 1 2 3 7 910 Elsevier Science USA.
Asha A. Bhende and Tara Kanitkar(2003) Principles of Population Studies Sixteenth Revised Edition Himalaya Publishing House Mumbai.
John R. Weeks (2005) Population: An Introduction to Concepts and IssuesNineth Edition Wadsworth Publishing Company Belmont California
Pathak K.B.andF.Ram(1998): Techniques of Demographic Analysis2 Nd Ed Himalaya Publishing house Bombay
United Nations (1974): Methods of Measuring Internal Migration Manual VI UN New York.
United Nations (2004): World Urbanization Prospects The 2003 Revision New York.

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&

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:
……

Further Suggestions:
……

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours)**	Year: **Fourth**	Semester: **Eighth**
Subject: **STATISTICS**		
Course Code: -**B060805PF**	**Course Title: Econometrics, Experimental Techniques and Sampling Methods Lab**	

Course outcomes: After completing this course a student will have:

1. Ability to select and fit appropriate statistical models.
2. Ability to develop skills to detect and correct model issues.
3. Gain the ability to design efficient and effective experiments.
4. Ability to interpret statistical results accurately.
5. Become proficient in making reliable data-driven conclusions.

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

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

	Topic	No. of Lectures
	1. Problems Based on OLSE in the General Linear Model 2. Problems Based on GLS Estimation 3. Problems Based on inference in linear models. 4. Problems Based on Autocorrelation 5.Problems Based on One-way and Two-way ANOVA 6.Problems Based on Handling Missing Data in Experimental Designs 7.Problems Based on Factorial Experiment 8.Problems Based on Efficiency and Optimality Criteria of Experimental Designs 9.Problems Based on Sampling Methods	**120**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

As suggested for paper code B060801TF/ B060802TF/ B060803TF and B060804TF.

Suggested Continuous Evaluation Methods:

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

Practical File/Record	**(05 marks)**
Assignment based on B060801TF/ B060802TF/ B060803TF/B060804TF	**(05 marks)**
Case Study based on B060801TF/ B060802TF/ B060803TF/B060804TF	**(10 marks)**
Class Interaction	**(05 marks)**

Suggested Practical Examination Evaluation Methods: (75 Marks)

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

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

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

Course prerequisites: To study this course, a student must have opted/passed the **paper code B060801TF/ B060802TF/ B060803TF/B060804TF.**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Vishwas Tiwari

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours with Research)**	Year: **Fourth**	Semester: Seventh
STATISTICS		
Course Code: **-B060706RF**	**Course Title: Research Project**	

Course outcomes: After completing this course a student will have:

1. Identify a statistical research problem relevant to real-world or theoretical contexts.
2. Conduct a literature review to understand existing work and research gaps.
3. Formulate research objectives and methodology using appropriate statistical tools.
4. Design a data collection plan using suitable sampling and data sources.
5. Prepare a structured research proposal with clarity, coherence, and academic integrity.

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

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

	Topic	No. of Lectures
	The Research Project course in the VII Semester of the Statistics program is designed to equip students with the foundational skills needed to undertake independent research. It involves identifying a relevant statistical problem, conducting a comprehensive **literature review,** and formulating clear **research objectives** and **hypotheses**. Students learn to design an appropriate methodology, including selecting **sampling techniques,** identifying data sources, and planning data collection strategies. The course also emphasizes academic writing, research ethics, and time management. By the end of the semester, students are expected to submit and present a detailed research proposal that will form the basis of their final project in the VIII Semester.	**60**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **B.Sc.(Honours with Research)**	Year: **Fourth**	Semester**: Eighth**
STATISTICS		
Course Code: **-B060806RF**	**Course Title: Research Project**	

Course outcomes: After completing this course a student will be able to:

1. Apply suitable statistical techniques to analyze the collected research data.
2. Interpret and evaluate the results in alignment with the research objectives.
3. Use statistical software tools like R & SPSS for data analysis and visualization.
4. Prepare a comprehensive research report following academic and ethical standards.
5. Present and defend research findings effectively through oral presentation and viva voce.

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

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

	Topic	No. of Lectures
	The VIII Semester Research Project course in Statistics focuses on the execution and completion of an independent research study based on the proposal developed in the previous Semester. Students collect data using appropriate sampling methods, apply relevant statistical techniques for analysis, and use software tools such as R & SPSS to process and interpret the data. Emphasis is placed on drawing meaningful conclusions, discussing findings in the context of existing literature, and preparing a well-structured research report. The course concludes with the submission of the final research report and an oral presentation or viva voce to evaluate the student's understanding and communication of their research work.	**60**

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060901TF**	Course Title: **Statistical Inference**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand and apply various estimation methods such as moments, maximum likelihood, least squares, and chi-square.
- ✓ Analyze properties of estimators including asymptotic efficiency, consistency, unbiasedness, and sufficiency.
- ✓ Understand and apply the factorization theorem and exponential family of distributions for UMVU estimation.
- ✓ Understand the concepts of prior and posterior distributions, loss function, risk function, and Bayes estimators.
- ✓ Develop proficiency in hypothesis testing methods including MP tests, UMP tests, and Neyman-Pearson lemma.
- ✓ Evaluate the relationship between tests and confidence bounds in statistical analysis.
- ✓ Apply similarity and unbiasedness in hypothesis testing and understand the asymptotic properties of likelihood ratio tests.
- ✓ Integrate statistical decision theory concepts in the context of decision functions, minimax and Bayes criteria.

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

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

Unit	Topic	No. of Lectures
I	Estimation Techniques: Estimation by methods of moments, maximum likelihood, least squares, minimum chi-square, and modified minimum chi-square.	**06**
II	Properties of Estimators: Properties of maximum likelihood and other estimators, asymptotic efficiency, consistency, unbiasedness, efficiency, sufficiency, completeness, and ancillary statistics.	**08**
III	Factorization Theorem and Exponential Family: Factorization theorem, exponential family of distributions and its properties, uniformly minimum variance unbiased (UMVU) estimation.	**08**
IV	Bayesian Estimation: Prior and posterior distributions, loss function, risk function, minimax estimator, and Bayes estimators.	**08**
V	Hypothesis Testing - MP and UMP Tests: MP tests, Neyman-Pearson lemma, UMP tests, and monotone likelihood ratio.	06
VI	Testing Methods: Similar and unbiased tests, UMPU tests for single-parameter likelihood ratio test and its asymptotic distribution.	**06**
VII	Confidence Bounds and Their Relation to Tests: Confidence bounds and their relationship with tests.	**09**
VIII	Advanced Testing and Decision Theory: Likelihood ratio tests, asymptotic behavior of likelihood ratio tests, large sample theory in hypothesis testing, and decision functions in statistical decision theory.	**09**

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Rohatgi V.K. & Saleh, An Introduction to Probability and Mathematical Statistics
Casella G &Berger R. L., Statistical Inference
Kale B. K., A First Course on Parametric Inference
Dudewicz e. J. Mishra S.N., Modern Mathematical Statistics
Mood A.M., Graybill F.A. and Boes D.C. , introduction to Theory of Statistics.

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060902TF**	Course Title: **Optimization Techniques**	

Course outcomes:

After completing this course, a student will be able to:

- ✓ Demonstrate understanding of key optimization techniques and apply them to solve real-world problems.
- ✓ Formulate real-life problems into structured mathematical models for optimization.
- ✓ Solve integer programming problems using methods like Branch and Bound and Cutting Plane.
- ✓ Apply PERT/CPM techniques to network scheduling and optimize project timelines.
- ✓ Solve non-linear programming problems using convex and concave functions, quadratic, and separable programming.
- ✓ Implement inventory control models and apply deterministic and probabilistic demand models.
- ✓ Analyze strategic decision-making problems using game theory concepts like saddle points and mixed strategies.
- ✓ Select the appropriate optimization technique based on the problem's nature and requirements.

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

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

Unit	Topic	No. of Lectures
I	Assignment Problems: Introduction to assignment problems and methods for solving them. The Hungarian method for solving assignment problems. Applications of assignment problems in job assignments, transportation, and scheduling tasks.	06
II	Sequencing Problems: Introduction to sequencing and scheduling problems. Johnson's Rule for optimal sequencing of tasks. Multi-machine sequencing problems and their solution methods.	08
III	Dynamic Programming Methodology: Introduction to dynamic programming. Examples and applications of dynamic programming in various fields. Recursive relations and stages of dynamic programming. Solution of real-life problems using dynamic programming.	07
IV	Integer Programming: Formulation of integer programming problems. Unimodularity in integer programming. The Cutting Plane Method and its application. The Branch and Bound Method for solving integer programming problems.	07
V	Network Scheduling by PERT/CPM: Network models and techniques for scheduling projects. PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) as tools for project management. Calculating project duration, critical paths, and slack times. Applications of PERT/CPM in real-world project management.	08
VI	Non-Linear Programming: Solution methods for non-linear programming problems. Concepts of convex and concave functions. Kuhn-Tucker conditions for constrained optimization problems. Quadratic programming and separable programming as methods for solving non-linear problems.	08

VII	Replacement Problems and Inventory Control: Replacement problems, including types of replacement strategies and determining the economic life of assets. Inventory control objectives, functions, and classifications. Deterministic demand models and probabilistic demand models for inventory management. Single-period and multi-period inventory models. Inventory control systems like fixed order quantity and periodic review systems.	08
VIII	Game Theory and Simulation: Introduction to game theory and its applications. Saddle points, principles of dominance, and mixed strategies in 2Xn games. Introduction to simulation, including hand-computed and computer simulations. The use of simulation in operations research, its limitations, and real-life applications in decision-making.	08

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Taha, H.A. (1982) *Operational Research: An Introduction*; Macmillan.
Philips, D.T., Ravindran, A., and Solberg, J. *Operations Research: Principles and Practice*.
Kanti Swarup, P.K., and Singh, M.M. (1985) *Operations Research*; Sultan Chand & Sons.
Hillier, F.S., and Lieberman, G.J. (1962) *Introduction to Operations Research*; HoldenDay.
Saaty, T.L. (1961) *Elements of Queuing Theory with Applications*; McGraw Hill.
Churchman, C.W., Ackoff, R.L., and Arnoff, E.L. (1957) *Introduction to Operations Research*.
Panneerselvam, R. (2002) *Operations Research*; Prentice Hall.
Mustafi, C.K. (1988) *Operations Research, Methods and Practice*; Wiley Eastern Limited.

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060903TF**	Course Title: **Industrial Statistics**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand the importance of quality control in product and process management.
- ✓ Learn to construct and interpret various control charts.
- ✓ Analyze control chart performance using OC curves, ARL, and CUSUM charts.
- ✓ Apply single, double, multiple, and sequential acceptance sampling plans.
- ✓ Understand the concepts of Producer's/Consumer's risks, AQL, LTPD, and AOQL.
- ✓ Design and apply sampling plans for variable inspection using Dodge-Romig tables.

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

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

Unit	Topic	No. of Lectures
I	Introduction to quality & related concepts, meaning of quality control, importance of quality control in production systems, difference between process control and product control, and introduction to methods of statistical process control.	06
II	Control charts for variables including $\bar{X}$ (mean) charts, R (range) charts, and s (standard deviation) charts; construction, interpretation and applications in quality control.	08
III	Control charts for attributes including p (proportion defective), np (number of defectives), and c (number of defects) charts; their construction, interpretation and applications in quality control	08
IV	Understanding the concepts of Operating Characteristic (OC) curves and Average Run Length (ARL) in the context of control charts; choice between attributes & variable control charts, introduction to Cumulative Sum (CUSUM) charts and their advantages over Shewhart charts.	08
V	Fundamentals of acceptance sampling; Acceptance sampling for attributes including —single, double, multiple, and sequential sampling plans.	06
VI	Measuring the performance of sampling plans- Derivation and interpretation of OC, AOQ (Average Outgoing Quality), and ATI (Average Total Inspection) curves; explanation of Producer's Risk, Consumer's Risk, Acceptable Quality Level (AQL), Lot Tolerance Percent Defective (LTPD), and AOQL (Average Outgoing Quality Limit), ASN (Average Sample Number).	**06**
VII	Use of Dodge-Romig tables for designing and evaluating sampling plans; practical applications in industrial quality assurance and decision-making.	**09**
VIII	Sampling inspection plans for variables; advantages and disadvantages of variable sampling; Continuous sampling and continuous sampling plans (CSP)- formulation and application of sampling plans where the quality characteristic is measured on a continuous scale.	**09**

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

D.C. Montgomery. (2009): Introduction to Statistical Quality Control. Wiley. Wetherill, G.B. Brown, D.W.(1991): Statistical Process Control Theory and Practice, Chapman & Hall.
Ott, E. R.(1977): Process Quality Control (McGraw Hill)
Wetherill, G.B.(1977): Sampling Inspection and Quality control, Halsteed Press.
Duncan A.J.(1974): Quality Control and Industrial Statistics, IV Edition, Taraporewala and Sons.

Suggested Online Links/ Readings:

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

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060904TF**	Course Title: **Reliability Theory and Life Distributions**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand and apply basic concepts of reliability and failure models to components and systems.
- ✓ Analyze the reliability of coherent systems using various failure models, including Exponential, Weibull, and Lognormal.
- ✓ Estimate reliability parameters and apply life distributions like Exponential, Weibull, and Gamma.
- ✓ Understand and apply censored and truncated sampling methods in life testing experiments.
- ✓ Utilize advanced reliability models, including multi-component systems and Markov chains.
- ✓ Apply reliability theory and maintenance strategies to optimize system performance in real-world scenarios.

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

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

Unit	Topic	No. of Lectures
I	Introduction to Reliability and Failure Models: Basic concepts of reliability and measures, components and systems, failure rate and reliability functions, reliability of series and parallel systems and other simple configurations.	06
II	Coherent Systems and Hazard Rates: Coherent systems, reliability of coherent systems, hazard rate concepts, failure models: exponential, Weibull, normal, lognormal.	08
III	Life Distributions and Renewal Processes: Common life distributions and their properties: exponential, Weibull, Gamma, log normal, renewal density and renewal function.	08
IV	Estimation of Parameters and Reliability: Estimation of parameters of these distributions and estimation of reliability. Idea of two-type censored sampling, problems in life testing, censored and truncated experiments for exponential models.	08
V	Reliability Estimation and Data Analysis: Maximum likelihood estimation (MLE) for reliability models, Bayesian estimation techniques for reliability, analysis of life-testing data, software tools for reliability analysis and estimation.	06
VI	Advanced Reliability Models: Multi-component and multi-state systems reliability, mixed systems: series-parallel and parallel-series configurations, reliability analysis in systems with complex failure modes, introduction to Markov chains in reliability modeling.	06
VII	Maintenance and Reliability Optimization: Preventive maintenance strategies based on reliability data, reliability-centered maintenance (RCM) models, optimization of system reliability and performance, case studies on maintenance optimization.	09
VIII	Applications of Reliability Theory: Reliability in manufacturing, electronics, automotive industries, application in software engineering and network systems, case studies in medical devices and other critical systems.	09

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Crowder, M. J., Kimber, A. C., Smith, R. L., & Sweeting, T. J. (2017). *Statistical analysis of reliability data*. Routledge.

Barlow, R. E., & Proschen, F. (1985). *Statistical Theory of Reliability and Life Testing*. Holt, Rinehart, and Winston.

Lawless, J. F. (1982). *Statistical Models and Methods of Life Time Data*. John Wiley.

Bain, L. J., & Engelhardt, M. (1991). *Statistical Analysis of Reliability and Life Testing Models*.

Balagurusamy, E. (2017). *Reliability Engineering*. Wiley.

Nelson, W. B. (2003). *Applied Life Data Analysis*. Wiley.

Sinha, S. K. (1986). *Reliability and Life Testing*. Wiley.

Suggested Online Links/ Readings:

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

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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060905PF**	**Course Title: Optimization Techniques, Statistical Inference and Industrial Statistics Lab**	

Course outcomes: After completing this course a student will have:
1. Ability to apply optimization techniques and solve assignment problems, as well as PERT/CPM methods.
2. Ability to optimize inventory management using EOQ models and make strategic decisions using game theory in competitive scenarios.
3. Gain proficiency in applying estimation methods.
4. Ability to apply hypothesis testing principles using the Neyman-Pearson Lemma and UMP tests
5. Able to analyze and solve problems related to system reliability and use industrial statistics for quality control.

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

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

	Topic	No. of Lectures
	1. Problems based on Assignment Problems 2. Problems based on Network Scheduling by PERT/CPM. 3. Problems based on Non-linear Programming. 4. Problems based on Inventory Control. 5. Problems based on Game Theory. 6. Problems based on Estimation. 7. Problems based on Bayesian Estimation. 8. Problems based on Neyman-Pearson Lemma and UMP Tests. 9. Problems related to the Reliability Theory and Life Distribution Course. 10. Problems related to the Industrial Statistics Course.	120

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:
As suggested for paper code B060901TF/ B060902TF/ B060903TF and B060904TF.

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

Practical File/Record	**(05 marks)**
Assignment based on B060901TF/ B060902TF/ B060903TF /B060904TF	**(05 marks)**
Case Study based on B060901TF/ B060902TF/ B060903TF /B060904TF	**(10 marks)**
Class Interaction	**(05 marks)**

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

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

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

Course prerequisites: To study this course, a student must have opted/passed the **paper code B060901TF/ B060902TF/ B060903TF/B060904TF.**

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **STATISTICS**		
Course Code: **-B060906RF**	**Course Title: Research Project**	

Course outcomes: After completing this course a student will have:

1. Identify a statistical research problem relevant to real-world or theoretical contexts.
2. Conduct a literature review to understand existing work and research gaps.
3. Formulate research objectives and methodology using appropriate statistical tools.
4. Design a data collection plan using suitable sampling and data sources.
5. Prepare a structured research proposal with clarity, coherence, and academic integrity.

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

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

	Topic	No. of Lectures
	The Research Project course in the IX Semester of the Statistics program is designed to equip students with the foundational skills needed to undertake independent research. It involves identifying a relevant statistical problem, conducting a comprehensive **literature review,** and formulating clear **research objectives** and **hypotheses**. Students learn to design an appropriate methodology, including selecting **sampling techniques,** identifying data sources, and planning data collection strategies. The course also emphasizes academic writing, research ethics, and time management. By the end of the semester, students are expected to submit and present a detailed research proposal that will form the basis of their final project in the X Semester.	60

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B061001TF**	Course Title: **Multivariate Analysis**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand the concept and properties of the multivariate normal distribution and related statistical measures.
- ✓ Apply the Wishart distribution and correlation analysis in hypothesis testing and interval estimation.
- ✓ Use Mahalanobis D^2 and Hotelling's T^2 statistics for testing hypotheses on multivariate mean vectors.
- ✓ Perform classification, discrimination, and dimension-reduction techniques on multivariate data.
- ✓ Analyze multivariate datasets using factor analysis, discriminant analysis, canonical correlation, and PCA.
- ✓ Interpret multivariate analysis results and implement methods using statistical software tools.

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

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

Unit	Topic	No. of Lectures
I	Multivariate Normal Distribution: Multivariate normal distribution, Marginal and conditional distributions, Characteristic function and moments, Estimation of parameters (MLE), Distribution of sample mean vector	06
II	Wishart Distribution and Correlation: Wishart matrix: distribution and properties, Distribution of simple correlation coefficient, Applications in testing and interval estimation	08
III	Mahalanobis Distance and Hotelling's T^2 Statistic: Mahalanobis-D^2 statistic, Distribution of Hotelling's T^2 statistic, Applications in tests on mean vector for one or more multivariate normal populations, Testing equality of components of a mean vector in a multivariate population	08
IV	Classification and Discrimination: Classification procedures, Discrimination procedures	08
V	Factor Analysis: Introduction to factor analysis, Extraction and estimation methods, Interpretation of factors	06
VI	Discriminant Analysis: Linear discriminant analysis, Quadratic discriminant analysis, Assumptions and applications.	06
VII	Canonical Correlation Analysis: Concept of canonical correlations, Derivation and interpretation	09
VIII	Principal Component Analysis (PCA): Concept and computation of principal components, Applications and interpretation of PCA decision theory.	09

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Anderson, T.W. (1983): An Introduction to multivariate statistical analysis. 2nd Ed.Wiley.
Martin Bilodeau, David Brenner (1999). Theory of multivariate statistics, Springer.
Bhuyan K.C. (2005). Multivariate Analysis and its Applications,
Johnson, R. and Wychern (1992): Applied multivariate Statistical analysis, Prentice –Hall, 3rd Ed.
Giri N C (1977) Multivariate Statistical Inference (Academic Press)
Morrison, D.F. (1976): Multivariate statistical methods. 2nd.Ed. McGraw Hill.
Rencher, A.C.(1998). Multivariate Statistical Inference with Applications, Springer.
Seber, G.A. F. (2001): Multivariate observations. Wiley.
Alvin C Rencher. Methods of multivariate analysis. 2nd ed. USA: Wiley interscience;
2002.
TenkoRaykov& George A Marcoulides. An introduction to applied multivariate analysis. Taylor & Francis Group USA

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B061002TF**	Course Title: **Stochastic Processes**	

Course outcomes:

After completing this course, a student will be able to:

- ✓ Understand basic concepts and types of stochastic processes.
- ✓ Analyze Markov chains and compute transition probabilities.
- ✓ Classify states and examine long-term behavior of Markov processes.
- ✓ Apply random walk models and solve gambler's ruin problems.
- ✓ Explain branching and Poisson processes with practical relevance.
- ✓ Model real-world systems using birth and death processes...

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

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

Unit	Topic	No. of Lectures
I	Introduction to Stochastic Processes: Definition, importance, and applications of stochastic processes; classification: discrete vs continuous time and state spaces; basic properties and examples.	06
II	Types of Stochastic Processes: Detailed discussion of various types of stochastic processes: Bernoulli process, Poisson process, renewal process, and simple examples for illustration.	08
III	Markov Chains – Basics and Transition Probabilities: Definition of Markov chains, transition probability matrix, Chapman-Kolmogorov equations; simple examples and modeling real-life problems.	07
IV	Long-run Behavior of Markov Chains: Calculation of n-step transition probabilities, limit theorems, classification of states, recurrence, transience, periodicity, ergodicity, and stationary distributions.	07
V	Transient Markov Chains and Applications Transient and absorbing states; applications of transient Markov chains in queuing, inventory, and other systems.	08
VI	Random Walk and Gambler's Ruin Problem: One-dimensional random walk, symmetric and asymmetric walks; derivation and applications of the gambler's ruin problem.	08
VII	Branching Processes and Poisson Process: Concept of branching processes and extinction probability; definition and properties of the Poisson process with real-world applications.	08
VIII	Birth and Death Processes Pure birth and pure death processes; general birth-death process; applications from social, physical, and biological sciences.	08

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Parzen, E. (1999). Stochastic processes. Society for Industrial and Applied Mathematics.
Medhi, J. (1994). Stochastic processes. New Age International.
Hoel, P. G., Port, S. C., & Stone, C. J. (1986). Introduction to stochastic processes. Waveland Press.
Karr, A. F. (1984). Stochastic processes (Sheldon M. Ross). SIAM Review, 26(3), 448.
Karlin, S. (2014). A first course in stochastic processes. Academic press.
Bhat, B. R. (2004). Stochastic models: analysis and applications. New Age International.
Basu A.K. (2003).Introduction to Stochastic Processes, Narosa Publishing House.
Feller, W. (1968): Introduction to Probability and its Applications, Vol.1, Wiley Eastern.
Medhi, J, (1982): Stochastic Processes, Wiley Eastern.
Suddhendu Biswas (1995). Applied Stochastic Processes: A Biostatistical and Population oriented Approach, Wiley Eastern.
Bhat B.R. (2008) Stochastic Models: Analysis and Applications, New Age Publshers
Karlin, S. and Taylor,H.M.(1998) An Introduction to Stochastic Modelling, Edition 3, Academic Press

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B061003TF**	Course Title: **Biostatistics**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand and apply measures of disease occurrence including prevalence and incidence.
- ✓ Evaluate diagnostic tests using concepts of validity, reliability, and ROC analysis.
- ✓ Analyze clinical agreement using statistical tools like kappa statistics and intra-class correlation.
- ✓ Identify and control confounding and bias in epidemiological research.
- ✓ Interpret measures of association such as relative risk, odds ratio, and attributable risk.
- ✓ Assess causal relationships and generalizability in health-related studies.

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

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

Unit	Topic	No. of Lectures
I	Introduction to Disease Measurement: Measuring the occurrence of disease, Measures of morbidity: prevalence and incidence rates, Association between prevalence and incidence, Uses and limitations of prevalence and incidence, Problems in measuring incidence and prevalence.	06
II	Clinical Agreement and Reliability Metrics: Concept and importance of clinical agreement, Kappa statistics for agreement, Mantel-Haenszel test, Intra-class correlation for reliability	08
III	Validity and Reliability of Diagnostic Tests: Validity of screening tests: sensitivity and specificity, Predictive values: positive and negative predictive values, Overall accuracy of tests, Relationship between validity and reliability.	08
IV	Advanced Diagnostic Evaluation: ROC (Receiver Operating Characteristic) curve, Area under the ROC curve and its interpretation, Applications of ROC curve in evaluating tests	08
V	Epidemiological Concepts of Association and Causation: Concepts of association and causation, Causal inference in epidemiology, Types of errors: random error and bias, Confounding: definition and sources	06
VI	Bias and Confounding Control: Identification and control of confounding variables, Strategies to control confounding in study design and analysis, Measurement of interactions, Generalizability of study results	06
VII	Risk Estimation: Estimating association measures: absolute risk, relative risk, and odds ratio, Interpretation and applications of each risk estimate, Distinction between association and causation	09
VIII	Prevention and Retrospective Analysis: Estimating potential for prevention: attributable risk, Comparing relative risk and attributable risk, Odds ratios in retrospective studies, Odds ratios approximating prospective relative risk, Exact inference for odds ratio in matched case-control data.	09

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

Rossi R.J. (2010). Applied Biostatistics for Health Sciences, Wiley
Pullum W. (2006). An Assessment of Age and Data Reporting in the DHS Surveys, 1985-2003. DHS Methodological Report No. 5. Calverton, Maryland, Marco International Inc.
Royce A. Singleton and Bruce C. Straits, (1999): Approaches to Social Research, Oxford, Oxford University Press.
Young P V. (1994). Scientific Social Surveys and Research. Prentice-Hall, New York (4th Edition).
Altman D G: Practical Statistics for Medical Research, London: Chapman and Hall, 2006.
Rosner B: Fundamentals of Biostatistics, ed. 6, 2006.
Dunn G, Everitt B: Clinical Biostatistics: An Introduction to Evidence-based Medicine. Edward Arnold, 1995.

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:

……..

Further Suggestions:

……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B061004TF**	Course Title: **Actuarial Statistics**	

Course outcomes:

After completing the course, students will be able to:

- ✓ Understand and apply various probability distributions in the context of insurance models.
- ✓ Analyze survival functions and mortality measures for life insurance and annuity products.
- ✓ Interpret and construct life tables and apply analytical laws of mortality.
- ✓ Apply principles of compound interest and discounting in actuarial calculations.
- ✓ Evaluate and compute insurance premiums using standard premium principles.
- ✓ Develop and use individual risk models for claim distributions and assess life insurance and annuity benefits..

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

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

Unit	Topic	No. of Lectures
I	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.	06
II	Survival function; Uncertainty of age at death; Time until-death for a person; Curate future lifetime; Force of mortality.	08
III	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.	08
IV	Principles of compound interest – Nominal and effective rates of interest and discount; Force of interest and discount; Compound interest; Accumulation factor; Continuous compounding.	08
V	Principles of Premium Calculation – Properties of premium principles; Examples of premium principles.	06
VI	Individual risk models – Models for individual claims; Sum of independent claims; Approximations and their applications.	06
VII	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.	09
VIII	Life annuities – Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments; Commutation functions; Varying annuities; Recursions; Complete annuities; Net single premiums; Factors affecting mortality and selections.	09

Vishwas Tiwari
Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:

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.
Daykin, C. D., Pentikainen, T. and Pesonen, M. (1993). Practical Risk Theory for Actuaries. Chapman & Hall/CRC.
Deshmukh, S.R. (2009). Actuarial Statistics: An Introduction Using R, University Press, India.
Dickson, C. M. D. (2005). Insurance Risk and Ruin (International Series no.1 Actuarial Science), Cambridge University Press.
Klugman,S. A., Panjer, H. H., and Willmotand, G. E. (2019). Loss Models: From Data to Decisions. Willy publication.
Neill, A. (1977). Life Contingencies, Heinemann.
Rotar, V.I. (2015). Actuarial Models: The Mathematics of Insurance, 2nd ed., CRC Press, New York.
Spurgeon, E.T. (1972). Life Contingencies, Cambridge University Press.

Suggested Online Links/ Readings:

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation 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)	**(05 marks)**
Class Test-II (Descriptive Questions)	**(05 marks)**
Class Test-III (Descriptive Questions)	**(05 marks)**
Class Interaction	**(05 marks)**

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: **M. Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **STATISTICS**		
Course Code: **-B0601005PN**	**Course Title: Statistical Methods in Multivariate, Stochastic and Applied Analysis Lab**	

Course outcomes: After completing this course a student will have:
1. Estimate and visualize multivariate normal data.
2. Apply Mahalanobis Distance and Hotelling's T^2.
3. Use PCA for data reduction.
4. Analyze socioeconomic data with CCA and FA.
5. Solve problems using Markov, stochastic, actuarial, and biostat methods.

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

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

	Topic	No. of Lectures
	1. Problems based on Estimation and Visualization of Multivariate Normal Distribution 2. Problems based on Computation and Application of Mahalanobis Distance and Hotelling's T^2 3. Problems based on Principal Component Analysis (PCA). 4. Problems based on Canonical Correlation and Factor Analysis in Socioeconomic Data. 5. Problems based on Markov Processes. 6. Problems based on Stochastic Processes. 7. Problems based on Actuarial Statistics course. 8. Problems based on Biostatistics Course.	120

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Suggested Readings:
As suggested for paper code B061001TF/ B061002TF/ B061003TF and B061004TF.

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

Practical File/Record	**(05 marks)**
Assignment based on B0601001TF/ B0601002TF/ B061003TF/B061004TF	**(05 marks)**
Case Study based on B061001TF/ B061002TF/ B0601003TF /B061004TF	**(10 marks)**
Class Interaction	**(05 marks)**

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

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

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

Course prerequisites: To study this course, a student must have opted/passed the **paper code B061001TF/ B061002TF/ B061003TF/B061004TF.**

Suggested equivalent online courses:
……..

Further Suggestions:
……..

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur

Programme/Class: M. Sc.	Year: **Fifth**	Semester**: Tenth**
STATISTICS		
Course Code: **-B061006RF**	**Course Title: Research Project**	

Course outcomes: After completing this course a student will be able to:

1. Apply suitable statistical techniques to analyze the collected research data.
2. Interpret and evaluate the results in alignment with the research objectives.
3. Use statistical software tools like R & SPSS for data analysis and visualization.
4. Prepare a comprehensive research report following academic and ethical standards.
5. Present and defend research findings effectively through oral presentation and viva voce.

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

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

	Topic	No. of Lectures
	The **X Semester** Research Project course in Statistics focuses on the execution and completion of an independent research study based on the proposal developed in the previous Semester. Students collect data using appropriate sampling methods, apply relevant statistical techniques for analysis, and use software tools such as R & SPSS to process and interpret the data. Emphasis is placed on drawing meaningful conclusions, discussing findings in the context of existing literature, and preparing a well-structured research report. The course concludes with the submission of the final research report and an oral presentation or viva voce to evaluate the student's understanding and communication of their research work.	60

Dr. Vishwas Tiwari
Convener (Statistics)
C S.J.M. University, Kanpur