Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

DEPARTMENT OF STATISTICS

BACHELOR OF ARTS (Programme)

B.A. (Programme)

(Effective from Academic Year 2018-19)

PROPOSED SYLLABUS

XXXXX Revised Syllabus as approved by Academic Council on XXXX, 2018 and Executive Council on YYYY, 2018

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I. About the Department

The Department of Mathematical Statistics was established in August 1973, though the teaching of M.A. in Mathematical Statistics had been introduced as early as in July 1957 at the initiative of Professor Ram Behari as part of a development programme adopted by the Department of Mathematics. Professor H.C. Gupta was the first head of the Department and he can be credited with the setting up of a good school in Stochastic Processes. In 1971, the scope of post-graduate course in Mathematical Statistics was extended leading to M.Sc. degree in Statistics. In 1987, the Department of Mathematical Statistics was re-named as the Department of Statistics. The Department is running the post-graduate (M.A./M.Sc.), M.Phil. and Ph.D. Programmes in Statistics.

The Department imparts rigorous training and exposure to the students in computer education by way of introducing the latest state-of-the-art in the programming language and computer software to enable to the students to perform statistical data analysis. With a view to prepare research background of the students, the M.Phil. Course in Mathematical Statistics was introduced in 1977 and the same has been continually updated covering most of the topical areas of Theoretical and Applied Statistics at the specialization level.

The Department has laboratories equipped with the basic and modern computing facilities. There is a good collection of books in laboratories with latest titles in various areas of statistics. Two computer laboratories with latest computing systems and related equipment have been setup in the Department for the use of students, research scholars and teachers. Regarding the job opportunities, the Department has a placement cell operating since academic year 2005-06. The department also has Research Activity Cell, UDAAN – The Socio-Cultural cell and Heritage Club operating since the academic year 2016-17. We can take pride in the fact that students get suitable placement in Research Institutes or Industries or Government Departments. Significant number of students are selected in Indian Statistical Service (ISS) each year.

II. Introduction to CBCS (Choice Based Credit System)

Scope:

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

Definitions:

(i) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/Centre.

(ii) 'Course' means a segment of a subject that is part of an Academic Programme.

(iii) 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.

(vi) 'Discipline Specific Elective' (DSE) course is the domain specific elective course offered by the main discipline/subject of study. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature also, but these are needed to be offered by main discipline/subject of study.

(vii) 'Dissertation/Project' is an elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member.

Project work/Dissertation is considered as a special course involving application of knowledge in solving/analysing/exploring a real life situation /difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

(viii) 'Generic Elective' (GE) course is an elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure to other disciplines. A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

(ix) 'Ability Enhancement Courses' (AEC) also referred as Competency Improvement Courses/Skill Development Courses/Foundation Course. The Ability Enhancement Courses (AEC) may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC).

(x) 'AECC' are the courses based upon the content that leads to Knowledge enhancement. The two AECC are: Environmental Science, English/ MIL Communication.

(xi) 'AEEC' are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction. These courses are also referred to as Skill Enhancement Courses (SEC).

(xii) 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

(xiii) 'CGPA' is cumulative grade points calculated for all courses completed by the students at any point of time.

(xiv) 'SGPA' means Semester Grade Point Average calculated for individual semester.

(xv) 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

(xvi) 'Grand CGPA' is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age marks is given in the Transcript.

CBCS Course Structure for Under -Graduate (B.A.) Programme

Semester	Core Course (12)	Ability Enhancement Compulsory Course(AECC) (2)	Skill Enhancement Course(SEC) (2)	Discipline Specific Elective (DSE)(6)	Generic Elective GE (2)
1	DSC -1 (Core 1)	**AECC1**			
	DSC -2 A				
	DSC -3 A				
2	DSC -1 (Core 2)	**AECC2**			
	DSC -2 B				
	DSC -3 B				
3	DSC -1 (Core 3)		**SEC1 (SE – 1)**		
	DSC -2 C				
	DSC -3 C				
4	DSC -1 (Core 4)		**SEC2 (SE – 2)**		
	DSC -2 D				
	DSC -3 D				
5			**SEC3 (SE – 3)**	**DSE 1 [DSE 1 (i) / (ii)]**	
				DSE 2A	
				DSE 3A	
6			**SEC4 (SE – 4)**	**DSE 1 [DSE 2 (i) / (ii)]**	
				DSE 2B	
				DSE 3B	

LIST OF THE COURSES

Core Courses (DSC)

Core1: Basic Statistics and Probability

Core2: Statistical Methodology

Core3: Theory of Statistical Inference

Core4: Survey Sampling and Design of Experiments

Skill Enhancement Course (SEC)

SE-1: Data Analysis using Spread Sheet

SE-2: Statistical Computations using Software (SPSS/R)

SE-3: Simulation Techniques in Statistics

SE-4: Statistical Techniques for Research Methods

Discipline Specific Electives (DSE)

DSE 1(choose one)

DSE 1-(i) Demography

DSE 1-(ii) Applied Statistics- I

DSE 2 (choose one)

DSE 2- (i) Applied Statistics- II

DSE 2 - (ii) Demand Analysis and Linear Regression

Note:

1. There will be one batch of 15 students for practical classes.
2. Each practical will carry 50 marks including 25 marks for continuous evaluation and 5 marks for the oral test.
3. Colleges are advised and encouraged to conduct at least 50% of the practicals using spreadsheet (MS Excel) or any statistical package (SPSS/R/MATLAB).
4. At least four questions have to be compulsorily attempted in the final practical examination.
5. Hardcopy of practical file has to be maintained by the students for each practical paper.

III. B.A. (Programme) Details:

Programme Objectives (POs)

1. To imbibe strong foundation of statistics in students.
2. To familiarize students with basic to high-level statistical concepts.
3. To update students with mathematical tools that aid in statistical theory.
4. To teach/strengthen students' knowledge of spreadsheets, programming languages and statistical packages.
5. To promote application oriented pedagogy by exposing students to real world data.
6. To aid students do projects which prepare them for jobs ahead.

Programme Outcomes (PCOs)

This course exposes the students to the beautiful world of Statistics and how it affects each and every aspect of our daily life. The course is designed to equip students with all the major concepts of Statistics along with the tools required to implement them. Introduction to computer softwares help them in analysis of data by making optimum usage of time and resources. These sofwares give them the necessary support and an edge when progressing to their professional careers. Exposure to plethora of real life data helps in honing their analysing skills. Having practical component with every paper invokes their exploratory side and fine-tunes the interpretation abilities. Such a pedagogy goes a long way in giving them the required impetus and confidence for consultancy startups/jobs in near future. The structure of the course also motivates/helps the students to pursue careers in related disciplines, especially the actuarial sciences.

Programme Structure:

The B.A. (Programme) is a three-year course divided into six-semesters. A student is required to complete 132 credits for the completion of course and the award of degree.

		Semester	***Semester***
Part – I	First Year	Semester I	Semester II
Part – II	Second Year	Semester III	Semester IV
Part – III	Third Year	Semester IV	Semester VI

Semester wise Details of B.A. (Programme) Course & Credit Scheme

Course	*Credits	
	Theory+ Practical	Theory +Tutorials
I. Core Course (12 Papers)	12×4=48	12×5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical/Tutorial* **(12 Practical/Tutorials*)**	12×2=24	12×1=12
04 Courses from each of the 03 Disciplines of choice		
II. Elective Course **(6 Papers)**	6×4=24	6×5=30
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical/Tutorials* **(6 Practical/Tutorials*)**	6×2=12	6×1=6
Two Papers from each discipline of choice including paper of interdisciplinary nature.		
Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory (2 Papers of 4 credits each)	2×4=8	2×4=8
Environmental Science		
English/MIL Communication		
2. Skill Enhancement Course **(Skill Based) (4 Papers of 4 credits each)**	4×4=16	4×4=16
	Total credit=132	**Total credit=132**

Institute should evolve a system/policy about ECA/General Interest/Hobby/Sports/NCC/ NSS/ related courses on its own.

***wherever there is practical there will be no tutorials and vice-versa.**

Teaching:

The faculty of the Department is primarily responsible for organizing lecture work for B.A. (Programme). The instructions related to tutorials are provided by the respective registering units under the overall guidance of the Department. Faculty from some other Departments and constituent colleges are also associated with lecture and tutorial work in the Department.

There shall be 90 instructional days excluding examination in a semester.

(Add details about Projects/Dissertation and role of supervisor)

Teaching Pedagogy:

Teaching pedagogy involving class room interactions, discussion, presentation etc. to be detailed out. The description should not be more than 300 words and could be both in general for all the courses and even for some particular papers requiring specific pedagogy like project work, group activities, or live projects.

This section (for each paper) could include the class-wise/week-wise flow of the course.

Eligibility for Admissions:

(Mention the basis of admission to the BA Programme, preferable point wise- Mode of Admission -Entrance and Interview or only Entrance, Eligibility Criteria, Courses coverage for Entrance Test)

Assessment Tasks:

Comprising MCQs, Project work and presentations, design and production of course related objects, written assignments, open or closed book exams specifically designed to assess the Learning Outcomes. (Evidence of achieving the Outcomes).

Assessment of Students' Performance and Scheme of Examinations:

1. English shall be the medium of instruction and examination.
2. Assessment of students' performance shall consist of:

(Point wise details of internal assessment and end semester examination, their weightage and scheme to be given.)

(Assessment will be based on Learning Outcomes for the course.)

Pass Percentage & Promotion Criteria:

(Provide point wise details about Pass percentage & Promotion Criteria)

Semester to Semester Progression:

(Provide department policy about semester to semester progression, policy for re-appearance, policy in case of failing in one or more papers)

Conversion of Marks into Grades:

(Specify the formula for conversion of marks into grades)

Grade Points:

Grade point table as per University Examination rule.

CGPA Calculation:

As per University Examination rule.

SGPA Calculation:

As per University Examination rule.

Grand SGPA Calculation:

As per University Examination rule.

Conversion of Grand CGPA into Marks

As notified by competent authority the formula for conversion of Grand CGPA into marks is:
Final %age of marks = CGPA based on all four semesters × 9.5

Division of Degree into Classes:

Post Graduate degree to be classified based on CGPA obtained into various classes as notified into Examination policy.

Attendance Requirement:

(Specify components for marking attendance of students.)

Span Period:

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of **five** years from the date of admission to the Part-I/Semester-I of the B.A. (Programme).

Guidelines for the Award of Internal Assessment Marks BA Programme (Semester wise)

Mention the components of Internal Assessment and the scheme for awarding marks for students' attendance.

IV: Course wise Content Details for B.A. (Programme):

B.A. (Programme)

Semester I

Core 1: Basic Statistics & Probability

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- To motivate students towards intrinsic interest in statistical thinking.
- To analyze and interpret data.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Basic concepts of Statistics.
- Distinguish between different types of data.
- Graphical methods of displaying data.
- Measures of Locations.
- Concept of Bi-Variate Data.
- Method of Least Squares.
- Introduction to the basics of Probability

Unit I: Concepts of a statistical population and sample from a population, quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data. Presentation of data by tables and by diagrams, frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

Unit II: Measures of location (or central tendency) and dispersion, moments, measures of skewness and kurtosis, cumulants. Bi-variate data: Scatter diagram, principle of least-squares and fitting of polynomials and exponential curves.

Unit III: Correlation and regression. Karl Pearson coefficient of correlation, Lines of regression, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).

Unit IV: Random experiment, sample point and sample space, event, algebra of events, Definition of Probability -classical, relative frequency and axiomatic approaches to probability, merits and demerits of these approaches (only general ideas to be given). Theorems on probability, conditional probability, independent events. Bayes' theorem and its applications.

Suggested Readings:

1. Cochran, W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments. Wiley Eastern.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005). Fundamentals of Statistics (8^{th} ed. Vol. II). World Press, Kolkata.
4. Kempthorne, O. (1965). The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008). Design and Analysis of Experiments. John Wiley.

Practical/Lab Work

List of Practicals

1. Problems based on graphical representation of data: Histograms (equal class intervals and unequal class intervals), Frequency polygon, Ogive curve.
2. Problems based on measures of central tendency using raw data, grouped data and for change of origin and scale.
3. Problems based on measures of dispersion using raw data, grouped data and for change of origin and scale.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on Moments using raw data, grouped data and for change of origin and scale.
6. Relationships between moments about origin and central moments.
7. Problems based on Skewness and kurtosis.
8. Karl Pearson correlation coefficient (with/without change of scale and origin).
9. Lines of regression, angle between lines and estimated values of variables.

10. Lines of regression and regression coefficients
11. Spearman rank correlation with /without ties
12. Fitting of polynomials and exponential curves.

Week-wise Teaching Plan:

Week 1: Provide a foundation and motivation for exposure to statistical ideas subsequent to the course.

Week 2: Distinguish between a population and a sample, Identify the types of data (qualitative, quantitative, nominal, ordinal, time-series, discrete, and continuous), Presentation of data by tables. **Practical Work.**

Week 3-4: Apply graphical methods of displaying data, histograms, frequency polygons, Pareto charts, ogives, pie charts, and box-and-whisker plots. Read and analyze. **Practical Work.**

Week 5: Construct frequency distributions, Read and analyze frequency distributions. **Practical Work.**

Week 6: Calculate the measures of central tendency. For a sample or population of data for grouped data, for weighted data for probability distributions.

Week 7: Calculate the measures of variation for a sample of data for a population of data for grouped data for probability distributions. Calculate the measures of position. Calculate percentiles, Calculate quartiles.

Week 8: Bi-variate data: Scatter diagram, principle of least-squares and fitting of polynomials and exponential curves. **Practical Work.**

Week 9: Correlation and Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient. **Practical Work.**

Week 10: Theory of Regression, Lines of Regression, Multiple and Partial Correlations (for 3 variates only). **Practical Work.**

Week 11: Concept of Random experiment, sample point and sample space, event, algebra of events, Calculate combinations and permutations. **Practical Work.**

Week 12: Definition of Probability -classical, relative frequency and axiomatic approaches to probability, Merits and demerits of these approaches (only general ideas to be given). **Practical Work.**

Week 13: Apply the rules of probability (addition, multiplication). Apply the terms of probability (mutually exclusive, independent, and dependent), Theorems on probability. **Practical Work.**

Week 14-15: Conditional probability, & Bayes' theorem and its applications. Revision. **Practical Work.**

Facilitating the achievement of Course Learning Outcomes:

Unit No.	**Course Learning Outcomes**	**Teaching and Learning Activity**	**Assessment Tasks**
I	Statistical population and sample from a population,	Class room lectures and discussions.	Participation in class discussion.
I	Identify the types of data	Class room lectures and discussions.	Participation in class discussion.
I	Graphical methods of displaying data Frequency Distributions	(i) Class room lectures and discussions. (ii) Practical work based on the graphical methods. (iii) Practical work based on the frequency distributions.	(i) Participation in class discussion. (ii) Problems based on graphical methods. (iii) Problems based on frequency distributions.
A*	Understanding of fundamentals of Basic statistics.	Class Test/ Assignment work	Extent of clarity in theoretical concepts.
II	Measure of Central Tendency, Measure of Variation.	(i)Class room lectures and discussions. (ii) Practical work	(i) Participation in class discussion. (ii) Numerical Illustrations based on different topics.
III	Bi-variate Data, Correlation, Regression.		
IV	Theory of Probability		
B*	Understanding of concepts of Probability.	Class Test/ Assignment work	Extent of clarity in theoretical concepts.
C	Application of Basic Statistics & Probability	Presentation.	Ability to apply concepts of Basic Statistics & Probability

* As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester II

Core 2: Statistical Methodology

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- To know the difference between discrete and continuous random variables.
- To develop the thinking of students so that they can use the concepts of statistical probability distribution in real life.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Concept of random variables.
- Basic concepts of discrete & continuous distribution.
- Distinguish between WLLN & SLLN and their application.
- Central limit theorem (CLT) for i.i.d. variates, and its applications.
- Distinguish between Moments generating function & Cumulants generating function
- Concept of WLLN & SLLN and their application.
- Introduction to Chebychev's inequality.

Unit I : Random variables: Discrete and continuous random variables, pmf, pdf and cdf, illustrations of random variables and their properties, expectation of random variable and its properties. Moments and cumulants; moment generating function, cumulant generating function and characteristic function.

Unit II: Bivariate probability distributions, marginal and conditional distributions; independence of variates (only general idea to be given). Transformation in univariate and bivariate distributions.

Unit III: Point (or degenerate), Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Normal, Uniform, Exponential, Beta and Gamma distributions.

Unit IV: Markov inequality, Chebychev's inequality, WLLN and SLLN: Statements and applications, Central limit theorem (CLT) for i.i.d. variates, and its applications.

Suggested Readings:

1. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2003). An Outline of Statistical Theory (4th ed., Vol. I). World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V. K. (2007). Fundamentals of Mathematical Statistics (11th ed.). Sultan Chand and Sons.
3. Hogg, R. V., Craig, A. T. and Mckean, J. W. (2005). Introduction to Mathematical Statistics (6th ed.). Pearson Education.
4. Mood, A. M., Graybill, F. A. and Boes, D. C. (2007). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw Hill Publication.
5. Rohtagi, V. K. and Saleh, A. K. Md. E. (2009). An Introduction to Probability and Statistics (2nd ed.). John Wiley and Sons.
6. Ross, S. A. (2007). Introduction to Probability Models (9th ed.). Academic Press.

Practical/Lab Work

List of Practicals

1. Fitting of binomial distributions for n and p = q = ½ and for n and p given.
2. Fitting of binomial distributions computing mean and variance.
3. Fitting of Poisson distributions for give n and λ and after estimating mean.
4. Fitting of negative binomial.
5. Fitting of Suitable distribution.
6. Application Problems based on Binomial distribution.
7. Application problems based on Poisson distribution.
8. Application problems based on negative binomial distribution.
9. Problems based on Area property of normal distribution.
10. To find the ordinate for a given area for normal distribution.
11. Application based problems based on normal distribution.
12. Fitting of normal distribution when parameters are given/not given.

Week-wise Teaching Plan:

Week 1: Provide a foundation and motivation for exposure to statistical ideas subsequent to the course & discrete and continuous random variables with examples.

Week 2-3: Illustrations of random variables and its properties, pmf, pdf and cdf, expectation of random variable and its properties with numerical problems. **Practical Work.**

Week 4: Moments and cumulants: moment generating function, cumulant generating function and characteristic function with properties. **Practical Work.**

Week 5-6: Bivariate probability distributions, marginal and conditional distributions; independence of variates. **Practical Work.**

Week 7: Transformation in univariate and bivariate distributions.

Week 8-9: Point (or degenerate), Binomial distribution, Poisson distribution, Geometric distribution, with properties. **Practical Work.**

Week 10: Negative Binomial distribution and Hypergeometric distribution with properties. **Practical Work.**

Week 11-12: Normal distribution, Uniform distribution and Exponential distribution. **Practical Work.**

Week 13: Beta distribution and Gamma distributions with properties. **Practical Work.**

Week 14: Markov inequality, Chebychev's inequality, WLLN and SLLN: Statements and applications. **Practical Work.**

Week 15: Central limit theorem (CLT) for i.i.d. variates, and its applications. Revision. **Practical Work.**

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Discrete & continuous random variables. Illustrations of random variables and its properties.	Class room lectures with examples and discussions.	Participation in class discussion.

I	Pmf., pdf and cdf, expectation of random variable and its properties	(i) Class room lectures, with numerical problems. (ii) Showing practical relevance of the study, using illustrations.	(i) Participation in class discussion. (ii) Problems based on the topic.
I	Moment generating function, Cumulant generating function and Characteristic function with properties	(i) Class room lectures and discussions. (ii) Solving Numerical problems based on Topic.	(i) Participation in class discussion. (ii) Practicals based on study.
A*	Basic concept of random variables	Class Test/ Assignment work	Extent of clarity in theoretical concepts
II	Marginal and Conditional distributions; independence of variates Transformation in univariate and bivariate distributions	(i) Learning through group-discussion. (ii) Solving the problems & practical questions on the topics and discussion. (iii) Practical work.	(i) Participation in class discussion. (ii) Numerical Illustrations based on the topics. (iii) Showing practical relevance of the study, using illustrations.
III	Discrete & continuous probability distribution		
IV	Markov inequality, Chebychev's inequality, WLLN and SLLN: with application, Central limit theorem (CLT) and its applications.		
B*	Discrete & continuous probability distribution	Class Test/ Assignment work	Extent of clarity in theoretical concepts.
C*	Chebychev's inequality, WLLN and SLLN, Central limit theorem	Presentation.	Understanding of situations in which various inequalities are applicable.

*As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester III

Core-3: Theory of Statistical Inference

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- The basic idea about the sampling distributions and testing of hypothesis based on them.
- Estimating and drawing inference about the unknown population parameters and validating it using hypothesis testing.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

1. The sampling distributions and their applications in testing of hypothesis.
2. Desirable properties of point estimators based on which estimators can be compared.
   - Unbiasedness
   - Consistency
   - Efficiency
   - Sufficiency
3. Different methods of finding point estimators
   - Maximum Likelihood Estimation
   - Method of Least Squares
4. Methods to develop/find best point estimators based on the desirable properties (Using Cramer- Rao inequality, Rao-Blackwell theorem, and Lehmann- Scheffe Theorem).
5. General methods of constructing interval estimators (Confidence Intervals) for unknown population parameters.
6. Developing/ constructing best/most powerful statistical tests to test hypotheses regarding unknown population parameters using Neyman- Pearson Lemma.
7. Practical applications of estimation theory and hypothesis testing pertaining to all discussed methods.

Unit I: Definitions of random sample, parameter and statistic, null and alternative hypotheses, simple and composite hypotheses, level of significance and probabilities of Type

I and Type II errors, power of a test and critical region. Sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean.

Unit II: Large sample tests for single mean, difference of means**,** standard deviation and difference of standard deviations. Sampling distributions of chi-square, t and F: definitions, properties and relationships between them. Tests of Significance based on Chi-square (goodness of fit and independence of attributes), t distribution and F- distribution using classical and p-value approach.

Unit III: Estimation: Parametric space, sample space, point estimation, requirement of a good estimator, consistency, unbiasedness, efficiency, sufficiency, Minimum variance unbiased estimators. Cramer-Rao inequality: statement and application, Methods of estimation: maximum likelihood, least squares and minimum variance, statement of Rao-Blackwell theorem and Lehmann-Scheffe theorem. Properties of maximum likelihood estimators (illustration).

Unit IV: Interval Estimation: Confidence intervals for the parameters of normal distribution, confidence intervals for difference of mean and for ratio of variances. Neyman-Pearson lemma and MP test: statement and applications.

Suggested Readings:

1. Casella, G. and Berger, R.L. (2002). Statistical Inference (2^{nd} ed.). Thomson Duxbury.
2. Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley and Sons.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). An Outline of Statistical Theory (4^{th} ed., Vol. I). World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007). Fundamentals of Mathematical Statistics (11^{th} ed.). Sultan Chand and Sons.
5. Hogg, R.V., Craig, A.T. and Mckean, J.W. (2005). Introduction to Mathematical Statistics (6^{th} ed.). Pearson Education.
6. Rohtagi, V.K. and Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics (2^{nd} ed.). John Wiley and Sons.

Practical/Lab Work

List of Practicals

1. Large Sample Tests (Based on normal distribution).
2. Testing of goodness of fit.
3. Testing of independence of attributes based on 2 X 2 contingency table.
4. Testing of equality of two populations variances.
5. Applying the paired t-test for difference of means.
6. Maximum Likelihood Estimation.
7. Confidence interval for Binomial proportion.
8. Confidence interval for the difference of proportions.
9. Confidence interval for difference of population means.
10. Confidence interval for ratio of variances.
11. Type I and Type II errors.
12. Most powerful critical region (NP Lemma).

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Week-wise Teaching Plan:

Week 1-2: Definitions of random sample, parameter and statistic, null and alternative hypotheses, simple and composite hypotheses, level of significance and probabilities of Type I and Type II errors, power of a test and critical region. Sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean.

Week 3-5: Large sample tests for single mean, difference of means**,** standard deviation and difference of standard deviations. Sampling distributions of chi-square, t and F: definitions, properties and relationships between them. **Including Practical Work**.

Week 6-7: Tests of Significance based on Chi-square (goodness of fit and independence of attributes), t distribution and F- distribution using classical and p-value approach. **Including Practical Work**.

Week 8-9: Estimation: Parametric space, sample space, point estimation, requirement of a good estimator, consistency, unbiasedness, efficiency, sufficiency, Minimum variance unbiased estimators.

Week 10-11: Cramer-Rao inequality: statement and application, Methods of estimation: maximum likelihood, least squares and minimum variance, statement of

Rao-Blackwell theorem and Lehmann-Scheffe theorem. Properties of maximum likelihood estimators (illustration). **Including Practical Work.**

Week 12-13: Interval Estimation: Confidence intervals for the parameters of normal distribution, confidence intervals for difference of mean and for ratio of variances. **Including Practical Work.**

Week 14: Neyman-Pearson lemma and MP test: statement and applications. **Including Practical Work.**

Facilitating the Achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Definitions of random sample, parameter and statistic, Null and alternative hypotheses, simple and composite hypotheses, level of significance and probabilities of Type I and Type II errors, power of a test and critical region.	Class room lectures and discussions.	(i) Participation in class discussion. (ii) To frame the Null and alternative hypotheses from real life situations (based on their properties).
II	Sampling distribution of a statistic, sampling distribution of sample mean, standard error of sample mean. Large sample tests for single mean, difference of means**,** standard deviation and difference of standard deviations. Sampling distributions of chi-square, t and F: definitions, properties and relationships between them.	(i) Class room lectures and discussions. (ii) Practical applications based on sampling distributions.	(i) Participation in class discussion. (ii) Ability to apply concepts in practical examples.

I- II			**Class test/assignment on first two units**
III	Estimation: Parametric space, sample space, point estimation, requirement of a good estimator, consistency, unbiasedness, efficiency, sufficiency, Minimum variance unbiased estimators. Cramer-Rao inequality: statement and application, Methods of estimation: maximum likelihood, least squares and minimum variance, statement of Rao-Blackwell theorem and Lehmann-Scheffe theorem. Properties of maximum likelihood estimators.	(i) Class room lectures and discussions. (ii) Practical work.	(i) Participation in class discussion. (ii) Ability to apply concepts in practical examples. (iii) Maximum likelihood, least squares estimators from data.
IV	Interval Estimation: Confidence intervals for the parameters of normal distribution, Confidence intervals for difference of mean and for ratio of variances. Neyman-Pearson lemma and MP test: statement and applications.	(i) Class room lectures and discussions. (ii) Practical work.	(i) Participation in class discussion. (ii) Ability to apply concepts in practical examples.
III-IV			**Class test/assignment on last two units**

B.A. (Programme)

Semester IV

Core 4: Survey Sampling and Design of Experiments

Credits: 6 **Marks: 150**

Course Objectives:

- To learn about sample surveys, its need and objectives.
- To learn to draw appropriate sample and interpret the result.
- To learn to design and conduct experiments.
- To analyze and interpret the data.
- To know about official statistical system in India and functions of different agencies.

Course Learning Outcomes:

After completing this course, students have a clear understanding of:

- The basic concept of sample survey and its need.
- Simple random sampling.
- Stratified random sampling.
- Systematic sampling.
- One-way and two-way analysis of variance.
- Basic concepts of design of experiments.
- Completely randomized design.
- Randomized design.
- Latin square design.
- Missing plot techniques.
- Factorial experiments.
- Present official statistical system in India.
- Functions of C.S.O. and N.S.S.O.

Unit I: Indian Official Statistics: Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, major publications, their reliability and limitations. Agencies responsible for the data collection- C.S.O., N.S.S.O., Office of Registrar General: historical development, main functions and important publications. Sample Surveys: Basic concepts of sample survey: concept of sampling, need for sampling, complete enumeration v/s. sampling,

principles of sampling theory, principal steps in a sample surveys, planning and organization of a sample survey, sampling and non-sampling errors. Simple random sampling (SRSWR and SRSWOR): definition and procedures of selecting a sample, properties of simple random sample, estimation of mean and sampling variance of sample mean.

Unit II: Stratified random sampling: introduction, estimation of population mean and its variance, choice of sample sizes in different strata, comparison of stratified sampling under proportional and Neyman allocation with SRSWOR in terms of precision.

Systematic sampling: introduction to linear systematic sampling, estimation of sample mean and its variance (N=nk), comparison of systematic sampling with SRSWOR in terms of mean squares.

Unit III: Analysis of variance: one-way and two-way classified data with one observation per cell only. Design of experiments: Principles of Design of experiments, uniformity trails, completely randomized, Randomized block and Latin square designs.

Unit IV: Missing plot technique: Analysis under a single missing observation: Missing plot technique for RBD and LSD. Factorial experiments: 2^2 and 2^3 Factorial experiments: construction and analysis.

Suggested Readings:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005). Fundamentals of Statistics (8^{th} ed., Vol. II). World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005). An Outline of Statistical Theory (3^{rd} ed., Vol. II). World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2008). Fundamentals of Applied Statistics (4^{th} ed.). Sultan Chand and Sons.
4. Montgomery, D.C. (2001). Designs and Analysis of Experiments. John Wiley and Sons, New York.
5. Mukhopadhyay, P. (1998). Theory and Methods of Survey Sampling. Prentice Hall of India.
6. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Ashok, C. (1984). Sampling Theory of Surveys with Applications. Lowa State University Press, Lowa, USA.
7. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
8. www.mospi.gov.in/.

Practical/Lab Work

List of Practicals

1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by wr and wor and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size.
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods, Compare the efficiencies of above two methods relative to SRS.
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend.
7. Analysis of a one way/ two way ANOVA.
8. Analysis of a CRD, RBD.
9. Analysis of a LSD.
10. Analysis of an RBD with one missing observation.
11. Analysis of an LSD with one missing observation.
12. Analysis of 2^2 and2^3 factorial in CRD and RBD.

Week-wise teaching plan:

Week 1: Indian Official Statistics: Present Official Statistical System in India relating to census of population, agriculture, industrial production, and prices; methods of collection of official statistics, major publications, their reliability and limitations. Agencies responsible for the data collection- C.S.O., N.S.S.O., Office of Registrar General: historical development, main functions and important publications. **Presentations.**

Week 2-3: Sample Surveys: Basic concepts of sample survey: concept of sampling, need for sampling, complete enumeration v/s. sampling, principles of sampling theory, principal steps in a sample surveys, planning and organization of a sample survey, sampling and non-sampling errors.

Week 3-4: Simple random sampling (SRSWR and SRSWOR): definition and procedures of selecting a sample, properties of simple random sample, estimation of mean and sampling variance of sample mean. **Practical Work**.

Week 5-6: Stratified random sampling: introduction, estimation of population mean and its variance, choice of sample sizes in different strata, comparison of stratified sampling under proportional and Neyman allocation with SRSWOR in terms of precision. **Practical Work.**

Week 6-7: Systematic sampling: introduction to linear systematic sampling, estimation of sample mean and its variance (N=nk), comparison of systematic sampling with SRSWOR in terms of mean squares. **Practical Work.**

Week 8-9: Analysis of variance: one-way and two-way classified data with one observation per cell only. **Practical Work.**

Week 9-10: Design of experiments: Principles of Design of experiments, uniformity trails,

Week 11-12: Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD): Introduction, Structure, Model and Parameters, ANOVA, Advantages and Disadvantages, Uses. **Practical Work.**

Week 13: Relative efficiencies of RBD compared to CRD, LSD compared to CRD, LSD compared to RBD taking rows and columns as blocks. **Practical Work.**

Week 14: Missing plot technique. Analysis under a single missing observation: Missing plot technique (for RBD and LSD), Variance of the difference between two estimated treatment effects out of which one has 1 missing observation for both RBD and LSD. **Practical Work.**

Week 15: 2^2 and 2^3 Factorial experiments: Introduction, Terminology, Main effects and interactions, Notation, Standard order for treatment combinations, ANOVA, Yate's Algorithm. **Practical Work.**

Facilitating the achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Indian Official Statistics	Class room lectures and discussion.	(i) Participation in class discussion. (ii) Presentations.
I	Basic concepts of Sample Surveys	Class room lectures and discussion.	Participation in class discussion.

II	Simple random sampling, Stratified random sampling, systematic sampling	(i) Class room lectures and discussion. (ii) Practical work based on these sampling.	(i) Participation in class discussion. (ii) Distinguishing between different types of sampling and their applications. (iii) Class test/ assignment.
III	Analysis of Variance: one-way and two-way classified data with one observation per cell	(i) Class room lectures and discussion. (ii) Practical work based on ANOVA.	(i) Participation in class discussion. (ii) Understanding the layout, formulation of hypothesis, model, appropriate analysis, interpretation of result and conclusions.
III	Design of experiments: CRD, RBD and LSD	(i) Class room lectures and discussion. (ii) Practical work based on these Designs.	(i) Participation in class discussion (ii) Understanding the layout, formulation of hypothesis, model, appropriate analysis, interpretation of result and conclusions. (iii) Class test/ assignment
IV	Factorial designs with two or three levels	(i) Class room lectures and discussion (ii) Practical work based on these Designs.	(i) Participation in class discussion. (ii) Understanding the layout, identification of design, appropriate analysis, interpretation of results and conclusions. (iii) Class test/ assignment (iv) Project work and presentations.

B.A. (Programme)

Semester III

SE-I: Data Analysis using spread sheet

Credits: 4 **Marks: 100**

Course Objectives:

The learning objectives include:

- To insert and conduct calculations.
- To analyze and interpret data.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The fundamental concepts of Microsoft Excel.
- Introduction to statistical computing, analysis and graphical interpretation.
- Graphical representation of data by histograms, frequency polygon.
- Pie chart, Ogive, Boxplot and stem-leaf.
- Measures of central tendency.
- Measures of Dispersion.
- Fitting of polynomials, exponential curves.
- Plotting of probability distributions.
- Correlation and Regression.
- Testing of hypothesis.

Unit I: Graphical Representations-Role, historical perspective, terminology, types of class interval-inclusive, exclusive, Formula to generate class intervals, types of graphs-Histogram, frequency curve, frequency polygon, pie chart, Ogive-more than and less than, Box plot, stem-leaf.

Unit II: Measures of Central tendency-Arithmetic Mean, Harmonic Mean, Geometric Mean, Median and Mode explanation with example, Measures of Dispersion-Range, Semi Inter-quartile Range, Standard Deviation, Mean Deviation and explanation with example.

Unit III: Curve Fitting - Principle of least squares Method, fitting of various curves like Straight line, Second degree Polynomial, k^{th} degree Polynomial and exponential curves, Plotting of various probability distribution like Binomial, Poisson, Normal Distribution with suitable example.

Unit IV: Introduction to Correlation Analysis, role, uses, its properties and formula, Introduction to Regression Analysis, role, uses, properties of its coefficient and formula to calculate regression coefficient, Regression Line, explain with example.

Suggested Readings:

1. Artymiak, J. (2011). Beginning Open Office Calc: From Setting Up Simple Spreadsheets to Business Forecasting. Apress Publisher.
2. Billo, E. J. (2007). Excel for Scientists and Engineers Numerical Methods. John Wiley & Sons.
3. Carlberg, C. (2011). Statistical Analysis. Pearsons Education Inc.
4. Held, B. (2007). Microsoft Excel Functions and Formulas. Wordware Publishing, Inc.
5. Kanji, G.K. (2006). 100 Statistical Tests (3rd ed.). Sage Publication.
6. Remenyi, D., Onofrei, G. and English, J. (2011). An Introduction to Statistics using Microsoft Excel. Academic Publishing Limited.

Practical/Lab Work

List of Practicals

1. Make the continuous frequency table for the given set of observations.
2. Draw the Histogram, Frequency curve and Frequency polygon for given Data.
3. Draw the Pie chart and Ogive curve, for given Data.
4. Analysis the data and draw the Box plot, stem-leaf.
5. Find Arithmetic Mean, Harmonic Mean and Geometric Mean for grouped and ungrouped data.
6. Find Median and Mode for grouped and ungrouped data.
7. Find the measures of Dispersion.
8. Fit the straight line, exponential and second degree curve to given data.
9. Fit the Binomial Distribution for the given data.
10. Fit the Poisson Distribution when parameter is given or not given.

11. Fit the Normal distribution for the given data, also find expected frequency.
12. Find the Correlation coefficient for the given data.
13. Find the regression coefficient from the given data.
14. Fit the regression line x on y for the given data.
15. Fit the regression line y on x for the given data.

Week-wise Teaching Plan:

Week 1: Graphical Representations-Role, historical perspective, terminology, types of class interval-inclusive, exclusive, Formula to generate class intervals.

Week 2-3: Types of graphs-Histogram, frequency curve, frequency polygon, pie chart, Ogive-More than and Less than, Box plot, stem-leaf. **Practical Work.**

Week 4: Measures of Central tendency-Arithmetic Mean, Harmonic Mean, Geometric Mean. **Practical Work.**

Week 5: Measures of Median and Mode for grouped and ungrouped data explanation with example, **Practical Work.**

Week 6-7: Measures of Dispersion-Range, Semi Inter-quartile Range, Standard Deviation, Mean Deviation and explanation with example.

Week 8-9: Curve Fitting - Principle of least squares Method, fitting of various curves like Straight line, Second degree Polynomial, k^{th} degree Polynomial and exponential curves. **Practical Work.**

Week 10-11: Plotting of various probability distribution like Binomial Distribution and, Poisson Distributions. **Practical Work.**

Week 12: Plotting of Normal probability distribution and find expected frequencies, problems related to area properties. **Practical Work.**

Week 13: Introduction to Correlation Analysis, role, uses, its properties and formula Example based on correlation analysis.

Week 14: Introduction to Regression Analysis, role, uses, properties of its coefficient and formula to calculate regression coefficient.

Week 15: Fitting of Regression Line. **Practical Work.**

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	The fundamental concepts of data analysis by spread sheet	Class room lectures and discussions.	Participation in class discussion.
I	Types of class interval-inclusive, exclusive, Formula to generate of class intervals.	Class room lectures and discussions.	Participation in class discussion.
I	Types of graphs-Histogram, frequency curve, frequency polygon.	(i) Class room lectures and discussions. (ii) Practical work based on the graph and analysis.	(i) Participation in class discussion. (ii) Identification of appropriate graphical representation, analysis and interpretation of results and conclusion.
I	Pie chart, Ogive-More than and Less than		
I	Box-plot and stem-leaf		
A*	Understanding of fundamentals and spread sheet.	Class Test/ Assignment work	Extent of clarity in theoretical concepts
II	Measures of Dispersion and Measures of Central tendency.	(i) Class room lectures and discussions. (ii) Practical work based on the graph and analysis.	(i) Participation in class discussion. (ii) Identification of appropriate graphical representation, analysis and interpretation of results and conclusion.
III	Curve Fitting and plotting of probability distribution		
IV	Introduction to Correlation analysis		
B*	Introduction to Regression analysis.	Class Test/ Assignment work	Extent of clarity in theoretical concepts.
C	Application of Spread sheet. (optional)	Project Work and its presentation.	Ability to apply concepts of statistics and analyzing problems.

* As per requirements of Internal Assessment for B.A. (Programme)

B.A. (Programme)

Semester IV

SE-2: Statistical Computations using Software (SPSS/R)

Credits: 4 **Marks: 100**

Course Objectives:

This course will review topics in probability and statistics studied in core for data analysis. Introduction to SPSS for statistical computing, analysis and graphical interpretation would be done using software skills. The following problems can be done on any one of the statistical software to enhance data analysis skills using software.

(i) Fitting of Binomial, Poisson, Negative Binomial, Normal Distributions.

(ii) Applications of Chi-square, t and F Distributions.

(iii) Calculation of correlation coefficient, Rank Correlation, etc.

(iv) Fitting of polynomials and regression curves.

(v) Methods of estimation (MLE and method of Moments).

(vi) Selecting a simple random sample using random number tables.

Suggested Readings:

1. Cunningham, B.J. (2012). Using SPSS: An Interactive Hands-on approach.

Week-wise Teaching Plan:

Week 1: Introduction to SPSS: How to enter variable names and data. Generate a table of statistics and graph summarizing those statistics. Navigate the Variable View and Data View screens. Investigations of main menu and data editor tool bar. Save and open data and output files. To distinguish between variables measured at the nominal, ordinal and scale levels of measurements. To enter variables and their attributes.

Week 2: Use of count, compute, compute with if and select if rank feature.

Week 2-3: Concept of recode and visual binning, generation of frequency tables, to calculate measures of central tendency and measures of dispersion.

Week 4: To create basic graphs using Legacy Dialogs and Chart Builder methods, to edit basic graphs.

Week 5: Computation and interpretation of correlation coefficient (Pearson's and Spearman's). Test of significance for Pearson's correlation coefficient and Partial correlation coefficients.

Week 6: Fitting of polynomial and exponential curves using built in functions. Fitting of most suitable curve.

Week 7: Fitting and plotting of regression lines

Week 8: Generation of random sample from different distributions and their graphic representation.

Week 9: Calculations of CDF, to show CLT for different distributions. To plot the Normal Probability plot.

Week 10: Importing and Exporting files. How to deal with missing observations.

Week 11-12: Basics of Statistical inference for hypothesis testing, compute p-values and confidence interval. Testing of hypotheses - one sample t-test, paired sample t-test, Independent sample t-test.
Chi Square test for Goodness of Fit.

Week 13-14: Constructing bivariate table and Chi Square test of Independence of attributes.

Week 15: How to select a Simple random sample from a given population.

Week 15: Code editing using syntax file.

Facilitating the achievement of Course Learning Outcomes:

Unit	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Introduction to SPSS	Class room lectures and Practical work	Participation in class discussion and completion of assignment.
I	Exposure to the descriptive statistics and different types of graphs	Class room lectures and Practical work	Participation in class discussion and completion of assignment.
II	Generation of reports with detailed descriptive statistics	Class room lectures and Practical work.	Participation in class discussion and completion of assignment. Formulation of null
II	Understanding of the concept of different correlation coefficients		

II	Concept of lines of Regression		hypotheses; analyze and interpret the results.
III	Sampling procedures	Class room lectures and Practicals.	Participation in class discussion and completion of assignment.
III	Fitting of curves		
III	Generation of random numbers using different probability distributions		
IV	Understanding of Hypothesis Testing.	Project Work and its presentation.	Identification of appropriate Test of Hypothesis, formulation of null hypothesis. Ability to analyze the data, interpret the result and draw conclusion.

B.A. (Programme)

Semester V

SE - 3: Simulation Techniques in Statistics

Credits: 4 **Marks: 100**

Course Objectives:

The learning objectives include:

- Concept of simulation and simulation modelling.
- Generation of Pseudo random number generators as well as from standard statistical distributions. Monte-Carlo simulation technique.
- Application of simulation techniques.

Course Learning Outcomes:

After completing this course, students will possess skills concerning

- How simulation may be used to understand the behavior of real world systems by utilizing mathematical models with an emphasis on simulation.
- How to generate random numbers by the different methods.
- Hands-on experience in using simulation software packages/structured programming languages.

Unit I: Introduction: Need for simulation, general principles, simulation models, event type simulation.

Unit II: Random numbers generation: Pseudo random number generators, The inverse transform method, Discrete and Continuous distributions, Transformation of random variables.

Unit III: Applications of simulation: Monte Carlo simulation technique. Inventory problems, Queueing systems.

Unit IV: Advantages and disadvantages of simulation, simulation of languages, Scope of simulation technique.

Suggested Readings:

1. Fishman, G.S. (1996). Monte Carlo-Concepts, Algorithms and Applications, Springer.
2. Taha, H. A. (2010). Operations Research: An Introduction (9th ed.). Pearson.
3. Julian, R. (1971). Computer simulation Applications: Discrete Event Simulation for Synthesis and Analysis of Complex Systems. John Wiley & Sons.
4. Swarup, K., Gupta, P.K. and Mohan, M. (2001). Operations Research (9th ed.). Sultan Chand & Sons.
5. Payer, T. A. (1982). Introduction to simulation. McGraw Hill.
6. Voss, J. (2014). An introduction to statistical computing: A simulation-based approach (1st ed.). Wiley series in computational statistics.

Practical/Lab Work

List of Practicals

1. Pseudo random number generators; Generation of $U(0,1)$.
2. The inverse transform method applied to standard statistical distributions (discrete and continuous).
3. Monte Carlo simulation methods.
4. Applications to Inventory Controls, Queueing systems, etc.

Week-wise Teaching Plan:

Week 1-2:	Introduction to simulation, general principles, simulation models, broad overview.
Week 3-4:	Pseudo random number generation methods; Practical Work
Week 5-7:	The inverse transform method; from discrete distributions; Practical Work
Week 8-10:	The inverse transform method; from continuous distributions; Practical Work
Week 11-12:	Monte Carlo simulation technique; Practical Work
Week 13:	Applications of simulation; Practical Work
Week 14:	Appraisal of simulation technique.

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Introduction: Need for simulation, general principles, simulation models, event type simulation.	Class room lectures and discussions.	Participation in class discussion.
II	Pseudo random number generators	(i) Class room lectures and discussions. (ii) Practical work based on generation of random numbers.	(i) Participation in class discussion. (ii) Identification of random number, Monte-Carlo method, simulation worksheet, appropriate analysis, interpretation of results and conclusion.
	The inverse transform method; from discrete distributions.		
	The inverse transform method; from continuous distributions		
A*	Understanding of basic concept of simulation and generation of random numbers.	Class Test/ Assignment work	Extent of clarity in theoretical concepts
III	Applications of simulation	(i) Class room lectures and discussions. (ii) Practical work based on applications of simulation.	(i) Participation in class discussion. (ii) Identification of random number, Monte-Carlo method, simulation worksheet, appropriate analysis, interpretation of results and conclusion.
	Monte Carlo simulation technique. Inventory problems, Queueing systems.		
IV	Scope, Advantages and disadvantages of simulation.		
B*	Understanding of simulation in real life problems and scope of simulation in various fields of life.	Class Test/ Assignment work	Extent of clarity in theoretical concepts.

*As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester VI

STAT-SE-4: Statistical Techniques for Research Methods

Credits: 4 **Marks: 100**

Course Objectives:

The learning objectives include:

- To provide scientific approaches to develop the domain of human knowledge through the use of empirical data expressed in quantitative form.
- To enable the students to understand basic concepts and aspects related to research, various techniques to collect the data, analyze the data and interpret the results thereafter.

Course Learning Outcomes:

After completion of this course, students should have developed a clear understanding of:

- Research methodology.
- Research Problem.
- Research Designs.
- Comparative study of different methods of data collection.
- Guidelines for construction of questionnaires.
- Processing and Analysis of data.
- Interpretation and Report writing.

Unit I: Introduction: Meaning, objection and motivation in research, types of research, research approach, significance of research. Research problems: definition, selection and necessity of research problems.

Unit II: Survey Methodology and Data Collection, inference and error in surveys, the target populations, sampling frames and coverage error, methods of data collection, non-response, questions and answers in surveys.

Unit III: Processing, Data Analysis and Interpretation: Review of various techniques for data analysis covered in core statistics papers, techniques of interpretation, precaution in interpretation.

Unit IV: Develop a questionnaire, collect survey data pertaining to a research problem (such as gender discriminations in private v/s government sector, unemployment rates, removal of subsidy, impact on service class v/s unorganized sectors), interpret the results and draw inferences.

Suggested Readings:

1. Cochran, W.G. and Cox, G.M. (1959). Experimental Design. Asia Publishing House.
2. Kothari, C.R. (2015). Research Methodology: Methods and Techniques (3rd ed. reprint). New Age International Publishers.
3. Kumar, R. (2011). Research Methodology: A Step - by - Step Guide for Beginners. SAGE publications.

Project Work (using spread sheet and statistical packages –SPSS/R)

Week-wise Teaching Plan:

Week 1: **Research Methodology:** Introduction, meaning of research, objectives of research, types of research, research approaches, research methods versus research methodology, research process.

Research Problem: Importance and techniques involved in defining a research problem.

Week 2: **Research Design:** Important concepts relating to research design, different research design and basic principles of experimental design.

Week 3: **Design of Sample Surveys:** Census and sample survey, implications of a sample design, probability sampling, non-probability sampling. **Practical Work-Introduction to a software package.**

Week 4: **Methods of Data Collection:** Primary and Secondary data, Collection of primary data, difference between questionnaires and schedules. Guidelines for constructing questionnaire and successful interviewing. **Practical Work.**

Week 5: **Data Preparation: Processing and Analysis of Data:** Processing Operations, measures of central tendency and dispersion. **Practical Work.**

Week 6: **Sampling Fundamentals:** Sampling and non-sampling errors, sampling distributions, point and interval estimation. **Practical Work.**

Week 7: **Sampling Fundamentals:** Point and interval estimation. Sample size and its determination. **Practical Work.**

Week 8: **Testing of Hypothesis:** Basic concepts concerning testing of hypothesis**.** Test statistic, critical region, critical value and decision rule. **Project Work.**

Week 9: **Testing of Hypothesis:** Important Parametric Tests. Hypothesis testing of Means, and Proportions. **Project Work /Practical Work.**

Week 10: **Testing of Hypothesis:** Hypothesis testing for Difference between Means and Proportions. **Project Work/ Practical Work.**

Week 11: **Testing of Hypothesis:** Hypothesis testing for variance and equality of variances of two normal populations. **Project Work/ Practical Work.**

Week 12: **Chi-Square Tests:** Test of difference of more than two proportions, Test of Independence of Attributes. **Project Work/ Practical Work.**

Week 13: **Chi-Square Tests:** Test of Goodness of Fit.

Interpretation and Report Writing: Meaning and technique of interpretation. **Project Work/ Practical Work.**

Week 14: **Interpretation and Report Writing:** Steps involved in report writing and its significance. Layout, mechanics and precautions for writing research reports.

Submission of Project Work.

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Introduction to research methodology and technique of defining a research problem.	Class room lectures and discussions.	Participation in class discussion.
I	The basic principles of Experimental Designs and introduction to different research designs.	Class room lectures and discussions.	Participation in class discussion.
II	Concept of Sampling Designs	Class room lectures and discussions.	(i) Participation in class discussion. (ii) Identification of a research problem.
II	Methods of Data Collection		
II	Guidelines for constructing Questionnaire and successful		

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
	Interviewing		
II	Guidelines for constructing Questionnaire and successful Interviewing		
A*	Understanding of fundamentals of research methodology, research problem and research designs.	Class Test/ Assignment work	Extent of clarity in theoretical concepts
III	Understanding of Processing Operations.	Class room lectures and discussions.	(i) Participation in class discussion.
III	Descriptive and Inferential Analysis of data.		(ii) Development of a Questionnaire.
III	Sampling Distributions. Parametric Tests of Hypotheses. Chi -square Test.	Practical work using a software package.	Identification of appropriate Test of Hypothesis, formulation of null hypothesis, appropriate analysis, interpretation of results and conclusion.
B*	Understanding of Hypothesis Testing.	Class Test/ Assignment work	Extent of clarity in theoretical concepts.
IV	Application of research methodology.	Project Work and its presentation.	Ability to analyze the data, interpret the result and draw conclusion.

*As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester V

DSE1-(i): Demography

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- To collect valid Demographic data using different methods.
- To learn basic measures of Mortality, Fertility and Population Growth.
- To construct life tables.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Distinction between Vital Statistics and Demography.
- Errors in Demographic data.
- To check the completeness of registration data using Chandrasekaran-Deming formula.
- Use of Myer's and UN indices in evaluating age data.
- Use of Balancing Equations.
- Population Composition and Dependency Ratio.
- Sources of data collection on Vital Statistics and errors therein.
- Measurement of Population.
- Distinction between Rate and Ratio.
- Basic measures of Mortality.
- Concepts of Stable and Stationary Populations.
- Concept of Life Tables, their construction and uses.
- Basic measures of Fertility.
- Measures of Population Growth.

Unit I: Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekaran-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Unit II: Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

Unit III: Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

Unit IV: Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

Suggested Readings:

1. Fredrick, E.C., Dudley J.C. and Klein, S. (1973). Applied General Statistics (3rd ed.). Prentice Hall of India Pvt. Ltd.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2008). Fundamentals of Statistics (9th ed., Vol. II). World Press.
3. Keyfitz, N. and Beckman, J. A. (1984). Demography through Problems. Springer-Verlag, New York.
4. Mukhopadhyay, P. (1999). Applied Statistics. Books and Allied (P) Ltd.
5. Biswas, S. (1988). Stochastic Processes in Demography & Application. Wiley Eastern.

Practical/Lab Work

List of Practicals

1. To calculate CDR and Age Specific death rate for a given set of data.
2. To find Standardized death rate by:- (i) Direct method (ii) Indirect method.
3. To construct a complete life table.
4. To fill in the missing entries in a life table.
5. To calculate CBR, GFR, SFR, TFR for a given set of data.
6. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data.
7. Calculate GRR and NRR for a given set of data and compare them.

Week-wise Teaching Plan:

Week 1:	Meaning of Demography and Population Statistics, Coverage and Content Errors in Demographic data, Use of Balancing Equations.
Week 2-3:	Chandrasekaran-Deming formula, Population Composition, Dependency Ratio**,** Errors in Age data, Evaluation of Age data, Myer's and UN Indices.
Week 4:	Adjustment of Age data, Meaning of Vital Statistics, Vital events, Sources of data collection on Vital Statistics and errors they suffer from.
Week 5:	Measurement of Populati**on,** Distinction between Rate and Ratio, Ratio of Vital events, Measures of Mortality: Crude Death Rate. **Practical Work.**
Week 5:	**Data Preparation: Processing and Analysis of Data:** Processing Operations, measures of central tendency and dispersion. **Practical Work.**
Week 6:	Specific Death Rate, Standardized Death Rate, Direct and Indirect Methods of Standardization, **Practical Work.**
Week 7:	Infant Mortality Rate, Relative Merits and Demerits of all the Rates. **Practical Work.**
Week 8-9:	Concepts of Stable and Stationary Populations, Central Mortality Rate, Force of Mortality. Approximate expressions for Force of Mortality.
Week 10:	Introduction to Life Tables, Life Table Functions and Columns, Assumptions in the construction of Life Tables, Various relationships in the columns of a life table.
Week 11:	Construction of Life Tables, Uses of Life Tables. Introduction to the concept of Fertility, Difference between Fertility and Fecundity. **Practical Work.**
Week 12:	Measures of Fertility: Crude Birth Rate, General Fertility Rate. **Practical Work.**
Week 13:	Specific Fertility Rate, Total Fertility Rate, Relative merits and demerits of all the Rates. **Practical Work.**
Week 14-15:	Measures of Population Growth: Crude Rate of Natural Increase, Pearl's Vital Index, Gross Reproduction Rate, Net Reproduction Rate, their relative merits and demerits. **Practical Work.**

Facilitating the achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Distinction between Vital Statistics and Demography.	Class room lectures and discussions.	Participation in class discussion.
I	Errors in Demographic data	Class room lectures and discussions.	Participation in class discussion.
I	To check the completeness of registration data using Chandrasekaran-Deming formula.	Class room lectures and discussions.	Participation in class discussion.
I	Use of Myer's and UN indices in evaluating age data.	Class room lectures and discussions.	Participation in class discussion.
I	Use of Balancing equations, Population Composition and Dependency Ratio	Class room lectures and discussions.	Participation in class discussion.
	Understanding of the basic concepts in Demographic analysis and to take care of errors in demographic data.	Class Test/Assignment Work	Depth of understanding in theoretical concepts.
II	Sources of data collection on Vital Statistics and errors therein.	Class room lectures and discussions.	Participation in class discussion.
II	Measurement of Population, Distinction between Rate and Ratio.	Class room lectures and discussions.	Participation in class discussion.
II	Basic measures of Mortality.	(i) Class room lectures and	Participation in class discussion.

		discussions. (ii) Practical work based on different measures of mortality.	
	Understanding the primary sources of data collection on Vital events and learning some of the important measures of mortality.	Class Test/Assignment Work	(i)Depth of understanding in theoretical concepts. (ii)Ability to choose appropriate measures of mortality in different situations with clear reasoning.
III	Concepts of Stable and Stationary Populations.	Class room lectures and discussions.	Participation in class discussion.
III	Concept of Life Tables, their construction and uses.	(i) Class room lectures and discussions. (ii) Practical work based on the construction of life tables.	Participation in class discussion.
	Learning the concepts of Complete and Abridged Life Tables and their construction.	Class Test/Assignment Work	Depth of understanding in theoretical concepts.
IV	Basic measures of Fertility. Measures of Population Growth.	(i) Class room lectures and discussions. (ii) Practical work based on different measures of fertility and population growth.	Participation in class discussion.

	Learning the basic measures of Fertility and Population growth.	Class Test/Assignment Work	(i) Depth of understanding in theoretical concepts. (ii) Ability to choose appropriate measures of fertility and population growth in different situations with clear reasoning.
	Application of the concepts learnt. (Optional)	Project Work/Presentation	Ability to apply the concepts learnt in real life.

B.A. (Programme)

Semester V

DSE 1-(ii): Applied Statistics- I

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- To give suitable exposure to applied fields of statistics viz. Index Numbers and Time Series.
- Hands-on experience at working with data in fields mentioned above.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- The fundamental concepts of Index Numbers, Construction of price and quantity Index numbers.
- Construction of Chain Index numbers and its utility.
- How to construct Consumer price Index and to understand its significance.
- Time series data, components of time series data, study the behaviour and identifying the variation due to different components in the data.
- Fitting of various mathematical curves, and growth curves to get trends and to forecast.
- Estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages and Link Relative method.
- To measure random component.

Unit I: Index Numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher. Factor reversal and time reversal tests. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

Unit II: Introduction to times series data, application of time series from various fields. Components of a times series, Decomposition of time series.

Unit III: Trend: Estimation of trend by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves. Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series.

Unit IV: Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages and Link Relative method, Deseasonalization. Random Component: Variate component method.

Suggested Readings:

1. Chatfield, C. (1980). The Analysis of Time Series –An Introduction. Chapman & Hall.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics (8^{th} ed., Vol. I & II). The World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V. K. (2008). Fundamentals of Applied Statistics (4^{th} ed.). Sultan Chand and Sons.
4. Kendall, M.G. (1976). Time Series. Charles Griffin.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007). Introduction to the Theory of Statistics (3^{rd} ed.). Tata McGraw-Hill Pub. Co. Ltd.
6. Mukhopadhyay, P. (2011). Applied Statistics (2^{nd} ed.). Books and Allied.

Practical/Lab Work

List of Practicals

1. Calculate price and quantity index numbers using Laspeyre's, Paasche's, Marshall-Edgeworth and Fisher's formulae.
2. To calculate the Chain Base index numbers for a given series of Fixed Base index numbers and show that the two are same.
3. To compute Chain Base index numbers for a given set of data.
4. To convert the Chain Base index numbers to Fixed Base index numbers.
5. Fitting and plotting of modified exponential curve by method of three selected points.
6. Fitting and plotting of Gompertz curve by method of partial sums.
7. Fitting and plotting of logistic curve by method of three selected points.
8. Fitting of trend by Moving Average Method (for n even and n odd) 16.
9. Measurement of Seasonal indices Ratio-to-Trend method.
10. Measurement of Seasonal indices Ratio-to-Moving Average method.
11. Measurement of seasonal indices Link Relative method.
12. Calculation of variance of random component by variate difference method.

Week-wise Teaching Plan:

Week 1: **Index Numbers:** Introduction, basic problems involved in the construction of Index Numbers, Construction of Index Numbers: Simple Aggregate Method, Weighted Aggregate Method, Comparison and interpretation. **Practical Work**.

Week 2-3: **Criteria of a good Index number:** Unit test, Time reversal Test, Factor reversal test, Errors in Measurement of Price and Quantity Index Numbers and their Control. **Practical Work.**

Week 4-5: Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price Index Numbers. Importance and interpretation. **Practical Work.**

Week 6: **Introduction to times series data**: Components of a times series, Decomposition of time series-Additive and multiplicative model with their merits and demerits. **Practical Work.**

Week 7: Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages. **Practical work.**

Week 8-9: Measurement of trend by method of least squares (quadratic and exponential). Fitting of various other mathematical curves and growth curves. **Practical Work.**

Week 10: Measuring of trend by method of moving average. **Practical Work.**

Week 11: Detrending: Effect of elimination of trend on other components of the time series. **Practical Work.**

Week 12: **Seasonal Component**: Estimation of seasonal component by Method of simple averages, Ratio to Trend. **Practical work.**

Week 13: **Seasonal Component:** Estimation of seasonal component by Method of Moving Averages. **Practical work.**

Week 14: **Seasonal Component:** Estimation of seasonal component by Method of Link Relative. Deseasonalization of data. **Practical work.**

Week 15: **Random Component in a Time Series**: Variate component method and its significance. **Practical work.**

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Index Numbers, construction of price and quantity index numbers.	Class room lectures and discussions.	Participation in class discussion.
I	Component of errors in the construction of Index Numbers	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
I	Construction of Chain index numbers	(i)Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
I	Construction of wholesale and Consumer price Index and its significance.	(i)Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
A*	Understanding basic concepts with relevance and importance of index numbers.	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
II	Time series data, components of time series data, study the behaviour and identifying the variation due to different components in the data.	Class room lectures and discussions.	Participation in class discussion.

II	Identify and measure various components of time series data.	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
B*	Understanding basic concepts with relevance and importance of index numbers.	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
III	Measurement of Trend by various methods.	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
III	Fitting various mathematical curve, and growth curves.	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
III	Effect of elimination of trend on other components of the time series	i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
C*	Understanding basic concepts of fitting and effects of elimination of trend on other component	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.

IV	Estimation of seasonal component by Method of simple averages, Ratio to Trend. Ratio to Moving Averages and Link Relative method	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
IV	Random Component: Variate component method.	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
D*	Understanding basic concepts of estimation of seasonal and random component	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
E*	Understanding of complete course.	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
F*	Application of Index Numbers, Time Series, (optional)	Project Work and its presentation.	Ability to apply concepts of Index Numbers and Time Series on practical data, understanding and giving solutions to a problem.

*As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester VI

DSE 2-(i): Applied Statistics II

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- This course will help students to learn techniques and approach of SQC being used in industry to manufacture goods and services of high quality at low cost.
- This course will also give exposure to Sampling Inspection Plans.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Statistical process control tools- Control charts for variables, attributes.
- Statistical product control tools- Sampling inspection plans.

Unit I: Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration.

Unit II: Statistical Process Control - Seven tools of SPC, chance and assignable causes of quality variation. Statistical Control Charts for variables- Construction and Statistical basis of 3-σ Control charts, analysis of patterns on control chart, Control charts for variables: X-bar & R-chart, X-bar & s-chart.

Unit III: Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes.

Unit IV: Acceptance sampling plan: Principle of acceptance sampling plans. Single sampling plan their OC, AQL, LTPD, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

Suggested readings:

1. Goon, A.M., Gupta M.K. and Dasgupta B. (2002). Fundamentals of Statistics (8th ed., Vol. I & II). World Press, Kolkata.
2. Gupta, S.C., Kapoor V.K. (2007). Fundamentals of Applied Statistics (4th ed.). Sultan Chand and Sons, New Delhi.
3. Mukhopadhyay, P. (2011). Applied Statistics (2nd ed.). Books and Allied (P) Ltd.
4. Montogomery, D.C and Runger, G.C. (2008). Applied Statistics and Probability for Engineers (3rd ed.). Wiley India Pvt. Ltd.
5. Montogomery, D. C. (2009). Introduction to Statistical Quality Control (6th ed.). Wiley India Pvt. Ltd.

Practical/Lab Work

List of Practicals

1. Construction of X-bar and R chart (without trial control limits).
2. Construction of X-bar and s chart (without trial control limits).
3. Construction of p-chart (fixed sample size).
4. Construction of p-chart (variable sample size).
5. Construction of d-chart.
6. Construction of c- chart.
7. Construction of u-chart.
8. Single sampling inspection plan.
9. OC functions and OC curves.
10. Determination of the best plan on the ASN.

Week-wise Teaching Plan:

Week 1-2: Introduction to quality, dimensions of quality, Its concept, application and importance. Historical perspective of quality control. Quality system and standards: Introduction to ISO quality standards, Quality registration.

Week 3-4: Process and product control, Seven tools of SPC, Chance and Assignable causes of quality variation. Examples of patterns on control chart.

Week 5-8: Statistical Control Charts- Statistical basis of 3-σ Control charts, Control charts for variables: X-bar & R-chart, X-bar & s-chart. Rational Sub-grouping, Revised and Modified Control Limits. Practical work.

Week 9-12: Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability. Practical work

Week 13-15: Acceptance sampling plan: Principle of acceptance sampling plans. Single sampling plan with OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables. Practical work.

Facilitating the achievement of Course Learning Outcomes:

Unit No.	**Course Learning Outcomes**	**Teaching and Learning Activity**	**Assessment Tasks**
I	Introduction to Quality, its concept, application and importance. Historical perspective of quality control. Introduction to ISO quality standards. Statistical process control tools, causes of variation.	Class room lectures and discussions.	Participation in class discussion.
II / III	Statistical process control tools-Control charts for variables, attributes	(i) Class room lectures and discussions. (ii) Practical problems from the list of practical.	Participation in class discussion. Problem solving, Analyze and Interpret the results.
II / III	Understanding basic concepts and control charts.	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
IV	Statistical product control tools-Sampling inspection plans, Dodge and Romig plans	(i)Class room lectures and discussions. (ii) Practical problems	Participation in class discussion. Problem solving,

		from the list of practical.	Analyze and Interpret the results.
A*	Understanding of complete course.	Class Test/ Assignment work	Extent of clarity of theoretical concepts studied in the course.
B*	Application of statistical quality control. (optional)	Project Work and its presentation.	Ability to apply concepts of quality control, practical handling, understanding and giving solutions to a problem.

*As per requirements of Internal Assessment for B.A. (Programme).

B.A. (Programme)

Semester VI

DSE 2-(ii): Demand Analysis and Linear Regression

Credits: 6 **Marks: 150**

Course Objectives:

The learning objectives include:

- To learn about Demand Analysis, its important aspects of Economic Statistics.
- To learn about Pareto's law of Income Distribution.
- To learn about Utility and Production Function.
- To provide knowledge for simple and multiple regression models and practical uses.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:

- Demand Function.
- Price and income elasticity of demand.
- Income Distribution, income inequality and economic growth.
- Utility and Production Function.
- Simple Linear Regression Model - Statistical data analysis technique, concept of the least squares criterion, predict the value of dependent variable, lack of fit test.
- Multiple Linear Regression model- significance of regression.

Unit I: Demand Analysis: Demand function, price and income elasticity of demand, Partial and cross Elasticity of demand, nature of commodities, laws of supply and demand.

Unit II: Income distributions, Pareto – curves of concentration. Utility and Production Functions: utility function, constrained utility maximization, indifference curves, derivation of demand curve using indifference curves, production function, homogeneous production functions, Elasticity of substitution for linear homogeneous functions.

Unit III: Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares, properties of estimators, goodness of fit, tests of hypotheses, lack of fit and pure Error, Best Linear Unbiased Estimator (BLUE), confidence intervals.

Unit IV: Gauss-Markov theorem, Multiple Linear Regression: OLS Estimation of parameters; properties of OLS estimators, goodness of fit - R^2, partial regression coefficients and testing of hypotheses on parameters (individual and joint).

Suggested Readings:

1. Croxton, F.E., Cowden, D.J. and Klein, S. (1982). Applied General Statistics. 3rd Edn. Prentice Hall of India (P) Ltd.
2. Gupta, S.C. and Kapoor, V.K. (2007). Fundamentals of Applied Statistics. 4th Edn., Sultan Chand & Sons.
3. Montgomery, D.C., Peck, E.A. and Vining, G. G. (2006). Introduction to Linear Regression Analysis. 4th ed., John Wiley & Sons.
4. Soni, R.S. (1996). Business Mathematics with Application in Business and Economics. Pitamber Publishing Co.

Practical/Lab Work

List of Practicals

1. Fitting of demand curve / function and Estimation of price elasticity of demand from time series data.
2. Fitting of Pareto curve to income data.
3. Fitting of Lorenz curve of concentration.
4. Estimability when X is a full rank matrix.
5. Estimability when X is not a full rank matrix.
6. Simple Linear Regression.
7. Multiple Regression.
8. Tests for Linear Hypothesis.
9. Lack of fit.
10. Testing of hypothesis on individual regression coefficient.

Week-wise Teaching Plan:

Week 1-2: Demand function, price and income elasticity of demand, Partial and cross Elasticity's of demand, nature of commodities, laws of supply and demand. **Practical Work.**

Week 3-5: Income distributions, Pareto – curves of concentration. Utility and Production Functions: utility function, constrained utility maximization. **Practical Work.**

Week 6-7: Indifference curves, derivation of demand curve using indifference curves, production function, homogeneous production functions, Elasticity of substitution for linear homogeneous functions. **Practical Work.**

Week 8-9: Two Variable Case Estimation of model by method of ordinary least squares, properties of estimators. **Practical Work.**

Week 10-11: Goodness of fit, tests of hypotheses, lack of fit and pure Error, Best Linear Unbiased Estimator (BLUE), confidence intervals. **Practical Work.**

Week 12-13: Gauss-Markov theorem, Multiple Linear Regression: OLS Estimation of parameters; properties of OLS estimators. **Practical Work.**

Week 14-15: Goodness of fit - R^2, partial regression coefficients and testing of hypotheses on parameters (individual and joint). **Practical Work.**

Facilitating the achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Demand Analysis	Class room lectures and discussions. Practical work	Participation in class discussion.
II	Income distributions	Class room lectures and discussions. Practical work	Participation in class discussions.
II	Utility and Production Functions	Class room lectures and discussions. Practical work.	Participation in class discussion.
A*	Understanding of basic concepts and techniques	Class Test/ Assignment work	Extent of clarity in theoretical concepts
III	Simple Linear Regression	Class room lectures and discussions. Practical work.	Participation in class discussion.
III	Best Linear Unbiased Estimator		

IV	Gauss-Markov theorem		
IV	Testing of hypotheses on parameters	Class room lectures and discussions. Practical work.	Participation in class discussion and presentation.
B*	Understanding of various techniques	Class Test/ Assignment work	Extent of clarity in theoretical concepts.

*As per requirements of Internal Assessment for B.A. (Programme).