DEPARTMENT OF STATISTICS

The following courses were approved by the respective Committee of courses on 09.01.23. Draft syllabi are enclosed for further suggestions. All suggestions are welcome by 11.01.23, Wednesday before 11.59 pm for consideration of the related Committee of Courses to be held on Thursday, 12.01.23.

B. Sc. (H) Statistics

Category-I

DISCIPLINE SPECIFIC CORE COURSE-7: SAMPLE SURVEYS

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lectures	tutorials	practical		
Sample Surveys	4	3	0	1	B.Sc.(H) Statistics Sem I and II	DSC -1, 2, 4

Learning Objectives:

The learning objectives include:

- Tools and techniques for selecting a representative sample from a target population keeping in mind the objectives to be fulfilled.
- Obtain estimator of the population parameter on the basis of selected sample and study its properties.

Course Learning Outcomes:

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

- The fundamental concepts of population and sample
- The principles of sample survey
- The steps involved in selecting a sample
- Simple Random Sampling with or without replacement
- Stratified Sampling
- Systematic Sampling
- Ratio and Regression Methods of Estimation

SYLLABUS OF DSC-7

Theory

UNIT I **(10 Hours)**

Basics of Survey Sampling

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic

principles of sample survey, Steps involved in survey sampling.

UNIT II **(8 Hours)**

Simple Random Sampling

Simple random sampling (SRS) with and without replacement, their properties, procedures of selecting a simple random sample, estimation of population mean and total, sampling for proportions, determination of sample size, bivariate population.

UNIT III **(10 Hours)**

Stratified Random Sampling

Stratified Random Sampling: Estimation of population mean and total, Allocation of sample in different strata using equal, proportional, optimum and Neyman allocations, comparison with SRS, practical difficulties in adopting Neyman allocation, estimation of gain in precision due to stratification.

UNIT IV **(7 Hours)**

Systematic Random Sampling

Systematic Random Sampling: Estimation of population mean and total, comparison with SRS and stratified sampling in the presence of linear trend, Yates' correction, definition of circular systematic sampling.

UNIT V **(10 Hours)**

Ratio and Regression Method of Estimation

Ratio method of estimation, first approximation to ratio estimator and its bias, first approximation to variance of ratio estimator, estimator of variance of ratio estimator, comparison of ratio with SRS.

Regression method of estimation, first approximation to linear regression estimator and its bias, first approximation to variance of the linear regression estimator, estimator of variance of the linear regression estimator, comparison with SRS and ratio estimator.

Practical -30 Hours

List of Practicals :

1. To select 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 establish all properties relative to SRS.
3. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WOR and establish all properties relative to SRS.
4. Estimate mean, standard error and the sample size for SRSWOR.
5. Stratified Sampling: allocation of sample to strata by proportional. Compare the efficiencies of above method relative to SRS.
6. Stratified Sampling: allocation of sample to strata by Neyman's methods. Compare the efficiencies of above method relative to SRS.
7. Estimation of gain in precision in stratified sampling.
8. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend and using end's correction.
9. Ratio estimation: Calculate the population mean or total of the population. Calculate

mean squares. Compare the efficiency of ratio estimator relative to SRS.

10. Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiency of regression estimator relative to SRS.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

Essential Readings

- Cochran, W.G. (2011): Sampling Techniques (3rd Ed.), Wiley Eastern John Wiley and Sons..
- Sukhatme, P. V., Sukhatme, B. V., Sukhatme, S., Asok, C.(1984). Sampling Theories of Survey with Application, IOWA State University Press and Indian Society of Agricultural Statistics.
- Goon, A. M., Gupta, M. K. and Dasgupta, B. (2001): Fundamentals of Statistics (Vol.2), World Press.

Suggestive Readings:

- Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Applied Statistics, Sultan Chand and Sons.
- Singh, D. and Chaudhary, F. S. (2015): Theory and Analysis of Sample Survey Designs.
- Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
- Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE-8: ADVANCED THEORY OF PROBABILITY DISTRIBUTIONS

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the Course			Eligibility Criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Theory of Probability	4	3	0	1	B.Sc.(H) Statistics I and II	DSC-1, 2 and 4

Distributions					**Semester**	

Learning Objectives

The learning objectives of this course are as follows:

- The course introduces students to advanced discrete and continuous probability distributions, and their important characteristics.
- It will enable them to understand applications of these distributions.

Learning Outcomes

The learning outcomes of this course are as follows:

- Students will be familiar with important advanced discrete probability distributions and their properties.
- Students will be familiar with important advanced continuous probability distributions, and their properties.
- They will be able to apply their understanding of these distributions in real life problems related to different areas of statistics.

SYLLABUS OF DSC-8

Theory

UNIT I **(15 hours)**

Discrete Probability Distributions

Negative Binomial Distribution: Probability distribution, particular cases, moment generating function, cumulants, limiting case, derivation of moments from binomial distribution and recurrence relation for probabilities of negative binomial distribution. Examples and applications based on the distribution. Hypergeometric Distribution: Probability distribution, mean, variance, approximation to Binomial Distribution and recurrence relation. Examples and applications based on the distribution. Geometric Distribution: Probability distribution, lack of memory property, moments and moment generating function. Examples and applications based on the distribution. Multinomial Distribution: Probability distribution and practical application.

UNIT II **(15 hours)**

Continuous Probability Distributions

Rectangular or Uniform Distribution: Definition, probability distribution and cumulative probability distribution, moments, and moment generating function, characteristic function and mean deviation about mean. Examples and applications based on the distribution. Gamma Distribution: Definition and properties, probability distribution, mean, variance, moment generating function, cumulant generating function, additive property and limiting case. Examples and applications based on the distribution. Beta Distribution: Beta Distribution of the first kind: Definition, probability distribution and cumulative probability distribution, mean, variance and harmonic mean. Beta Distribution of the second kind: Definition, probability distribution, mean, variance and harmonic mean. Examples and applications based on the distributions.

UNIT III **(15 hours)**

Continuous Probability Distributions (contd.)

Exponential Distribution: Definition, probability distribution and cumulative probability distribution, moment generating function, mean, variance and lack of memory property. Examples and applications based on the distribution. Standard Laplace (Double Exponential) Distribution: Definition, probability distribution, characteristic function and moments. Two Parameter Laplace Distribution: Definition, probability distribution, characteristic function and moments. Examples and applications based on the distribution. Weibull Distribution: Probability distribution, moments and practical applications. Logistic Distributions: Probability distribution, moments and practical applications. Cauchy Distribution: Definition, probability distribution, characteristics function, additive property and moments. Examples and applications based on the distribution.

PRACTICAL – 30 Hours

List of Practicals:

1. Practical based on application of Negative Binomial Distribution.
2. Practical based on fitting of Negative Binomial Distribution.
3. Practical based on application of Hypergeometric Distribution
4. Practical based on fitting of Geometric Distribution.
5. Practical based on lack of memory property of Geometric Distribution
6. Practical based on application of Geometric Distribution.
7. Practical based on application of Multinomial Distribution.
8. Practical based on application of Rectangular Distribution
9. Practical based on application of Gamma Distribution.
10. Practical based on application of Beta Distribution.
11. Practical based on application of Exponential Distribution.
12. Practical based on lack of memory property of Exponential Distribution.
13. Practical based on application of Weibull Distribution.
14. Practical based on application of Logistic Distribution.
15. Practical based on application of Cauchy Distribution.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS.

ESSENTIAL READINGS

- Ross, Sheldon M.: A First Course in Probability, Ninth Edition, Pearson.
- Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, Twelfth Edition, Sultan Chand and Sons, Delhi.
- Miller, I. and Miller, M. (2006). John E. Freund's Mathematical Statistics with Applications, Eight Edition., Pearson Education, Asia.
- Mood, A.M. Graybill, F.A. and Boes, D.C. (2007). Introduction to the Theory of Statistics, Third Edition, (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

SUGGESTED READINGS

- Rohatgi, V. K and Saleh M. E. (2015). An Introduction to Probability and Statistics, Third Edition, John Wiley and Sons, Inc., New Jersey.
- Hogg, R.V., Tanis, E.A. and Rao, J.M. (2009). Probability and Statistical Inference, 7th Ed., Pearson Education, New Delhi.
- Ross, Sheldon M.(2009). Introduction to Probability and Statistics for Engineers

and Scientists, Fourth Edition, Academic Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9: MATHEMATICAL ANALYSIS (SEMESTER-III)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Analysis	4	3	0	1	Class XII pass with Mathematics	Nil

Learning Objectives

The learning objectives include:

- To study the Real Analysis, this deals with the analytical properties of real functions and sequences.
- To study the Numerical Analysis, this is the study of algorithms that use numerical approximation for the problems of mathematical analysis.

Learning Outcomes:

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

- Fundamental properties of real number and real-valued functions.
- Analytical properties of sequences.
- Infinite series, their properties and different tests.
- Limits, continuity, differentiability and mean value theorems.
- Fundamentals of numerical analysis, interpolation, numerical integration and difference equation.

SYLLABUS OF DSC-9

Theory

UNIT I **(10 hours)**

Set Theory and Sequences

Completeness: The Completeness property of R; Neighbourhood and limit points: Neighbourhood, Open Set, Closed Set, Limit Point of a Set; Sequences: Definition of a Sequence, Convergent Sequence, Divergent Sequence, Oscillatory Sequence, Cauchy Sequence, Monotone Sequence.

UNIT II **(10 hours)**

Series

Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Conditional convergence.

UNIT III **(10 hours)**

Limit and Continuity

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of sin(x), cos(x), log (1+x).

UNIT IV **(15 hours)**

Numerical Analysis

Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eights rule, Stirling's approximation to factorial n. Solution of difference equations of first order.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Formation of difference table, fitting of polynomial and missing terms for equal interval of differencing.
2. Based on Newton's Gregory forward difference interpolation formula.
3. Based on Newton's backward difference interpolation formula.
4. Based on Newton's divided difference and Lagrange's interpolation formula.

5. Based on Gauss forward, Gauss backward central difference interpolation formula.
6. Based on Stirling's central difference interpolation formula.
7. Based on Lagrange's Inverse interpolation formula.
8. Based on method of successive approximation or iteration.
9. Based on method of reversion of series.
10. Based on Trapezoidal Rule, Simpson's one-third rule, Simpson's three-eighth rule, Weddle's rule.
11. To find sum by Euler-Maclaurin summation formula

Essential Readings

- Appostol, T.M. (1987). Mathematical Analysis, 2nd Ed., Narosa Publishing House,New Delh
- Ghorpade, S.R. and Limaye, B.V. (2006). A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
- Sastry, S.S. (2000). Introductory Methods of Numerical Analysis, 3rd Ed., Prentice Hall of India Pvt. Ltd., New Delhi.

Suggestive Readings:

- Bartle, R.G. and Sherbert, D.R. (2002). Introduction to Real Analysis, (3rd Ed.,), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
- Jain, M.K., Iyengar, S.R.K. and Jain, R.K. (2003). Numerical methods for scientific and engineering computation, New age International Publisher, India.
- Malik, S.C. and Arora, S. (1994). Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
- Mukherjee, Kr. Kalyan (1990). Numerical Analysis. New Central Book Agency.
- Narayan, S. (1987). A course of Mathematical Analysis, 12th revised Ed., S. Chand &Co. (Pvt.) Ltd., New Delhi.
- Somasundram, D. and Chaudhary, B. (1987). A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

B.Sc. (P)/B.A(P) with Statistics as Major

Category II

DISCIPLINE SPECIFIC CORE COURSE – 5: SAMPLING DISTRIBUTIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sampling Distributions	4	3	0	1	Part I and II	DSC-1 and 3

Learning Objectives:

The learning objectives include:

- To understand the concept of sampling distributions and their applications in statistical inference.
- To understand the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Learning Outcomes:

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

- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Hypothesis testing based on a single sample and two samples using both classical and p value approach.
- Chi square distribution.
- Analyze categorical data by using Chi square techniques.
- t and F distributions and their applications.

SYLLABUS OF DSC-5

Theory

Unit I **(15 hours)**

Large sample tests

Large sample tests: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

Unit II **(15 hours)**

Chi square distribution

Chi square distribution: Definition and derivation of $\chi 2$ distribution with n degrees of freedom (d.f.) using m.g.f., nature of probability curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of $\chi 2$ distribution. Tests of significance and confidence intervals based on χ^2 distribution.

Unit III **(15 hours)**

t and F distributions

t and F distributions: Student's t and Fishers t-distributions, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of F distribution, nature of probability curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1,n_2)$. Relationship between t, F and $\chi 2$ distributions. Test of significance and confidence intervals based on t and F distributions.

PRACTICAL/LAB WORK - 30 hours

List of Practicals

1. Large Sample Tests:
   a) Testing of significance and confidence intervals for single proportion and difference of two proportions.
   b) Testing of significance and confidence intervals for single mean and difference of two means.
   c) Testing of significance and confidence intervals for difference of two standard deviations.
2. Tests based on Chi-Square Distribution:
   a) To test if the population variance has a specific value and its confidence intervals.
   b) To test the goodness of fit.
   c) To test the independence of attributes.
   d) Test based on 2 x 2 contingency table without and with Yates' corrections.

3. Tests based on t- Distribution and F- Distribution:
   a) Testing of significance and confidence intervals for single mean and difference of two means and paired t – test.
   b) Testing of significance and confidence intervals of an observed sample correlation coefficient.
   c) Testing and confidence intervals of equality of two population variances.

ESSENTIAL READINGS :

- Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th Ed., S. Chand and Sons. Delhi.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). An Outline of Statistical Theory, Vol. I, 4th Ed., World Press, Kolkata.
- Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). An Introduction to Probability and

Statistics, 2nd Ed., (Reprint) John Wiley and Sons.

SUGGESTIVE READINGS:

- Hogg, R.V. and Tanis, E.A. (2009). A Brief Course in Mathematical Statistics. Pearson Education.
- Johnson, R.A. and Bhattacharya, G.K. (2001). Statistics-Principles and Methods, 4th Ed., John Wiley and Sons.
- Mood, M.A., Graybill, F.A. and Boes, C.D. (2007). Introduction to the Theory of Statistics, 3rd Ed., (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6: STATISTICAL QUALITY CONTROL

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Statistical Quality Control	4	3	0	1	Basic Knowledge of Statistics	Nil

Learning Objectives

The learning objectives include:

- This course will help students to learn techniques and approaches 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.

Learning Outcomes:

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

- The concept of Statistical Quality Control and its application in Industry.
- Statistical process control tools- Control charts for variables, and attributes.
- Different patterns of variation on Control charts
- Statistical product control tools- Sampling inspection plans.

SYLLABUS OF DSC-6

Theory

UNIT I: Basics of Quality (9 hours)

Definition, dimensions of quality, its concept, application and importance. Introduction to Process and Product Control. Statistical Process Control - Seven tools of SPC, Chance and Assignable Causes of quality variation.

UNIT II: Statistical Control Charts (21 hours)

Construction and Statistical basis of 3-σ Control charts, Control charts for variables: $\bar{X}$& R-chart, $\bar{X}$ & s-chart. chart (for known and unknown parameters) Control charts for attributes: np-chart, p-chart, c-chart (for known and unknown parameters). Revised control limits. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart. Differentiate between Control Limits, Specification Limits and Natural Tolerance Limits. Concept of process capability.

UNIT III: Acceptance sampling plan (15 hours)

Principle of acceptance sampling plans. Single sampling plan it's OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation. Introduction to Dodge and Romig's sampling inspection plan tables.

PRACTICAL/LAB WORK - (30 hours)

List of Practical:

Mode of Conducting Practical Examination: The Students should be encouraged to perform practical problems on computers using whatsoever software/package as far as possible.

1. Construction and interpretation of statistical control charts for
a) $\bar{X}$& R-chart
b) $\bar{X}$& s-chart
c) np-chart
d) p-chart
e) c-chart
2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves.

ESSENTIAL READINGS

- Montgomery, D. C. (2009). Introduction to Statistical Quality Control, 6th Ed., Wiley India Pvt. Ltd.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I & II, 8th Ed., The World Press, Kolkata.

SUGGESTIVE READINGS:

- Gupta, S.C. and Kapoor, V.K. (2014). Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand.

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

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

B.Sc. (P)/B.A(P) with Statistics as Non-Major

Category III

DISCIPLINE SPECIFIC CORE COURSE – 3: SAMPLING DISTRIBUTIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sampling Distributions	4	3	0	1	Part I and II	DSC-1 and 3

Learning Objectives:

The learning objectives include:

- To understand the concept of sampling distributions and their applications in statistical inference.
- To understand the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Learning Outcomes:

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

- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Hypothesis testing based on a single sample and two samples using both classical and p value approach.
- Chi square distribution.
- Analyze categorical data by using Chi square techniques.
- t and F distributions and their applications.

SYLLABUS OF DSC-3

Theory

Unit I **(15 hours)**

Large sample tests

Large sample tests: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

Unit II **(15 hours)**

Chi square distribution

Chi square distribution: Definition and derivation of $\chi 2$ distribution with n degrees of freedom (d.f.) using m.g.f., nature of probability curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of $\chi 2$ distribution. Tests of significance and confidence intervals based on $\chi 2$ distribution.

Unit III **(15 hours)**

Exact Sampling Distributions

t and F distributions: Student's t and Fishers t-distributions, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of F distribution, nature of probability curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1,n_2)$. Relationship between t, F and $\chi 2$ distributions. Test of significance and confidence intervals based on t and F distributions.

PRACTICAL/LAB WORK - (30 hours)

List of Practicals

1. Large Sample Tests:
   d) Testing of significance and confidence intervals for single proportion and difference of two proportions.
   e) Testing of significance and confidence intervals for single mean and difference of two means.
   f) Testing of significance and confidence intervals for the difference of two standard deviations.

2. Tests based on Chi-Square Distribution:
   e) To test if the population variance has a specific value and its confidence intervals.
   f) To test the goodness of fit.

g) To test the independence of attributes.
h) Test based on 2 x 2 contingency table without and with Yates' corrections.

3. Tests based on t- Distribution and F- Distribution:

d) Testing of significance and confidence intervals for single mean and difference of two means and paired t – test.
e) Testing of significance and confidence intervals of an observed sample correlation coefficient.
f) Testing and confidence intervals of equality of two population variances.

Essential Readings :

- Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th Ed., S. Chand and Sons. Delhi.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). An Outline of Statistical Theory, Vol. I, 4th Ed., World Press, Kolkata.
- Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, 2nd Ed., (Reprint) John Wiley and Sons.

Suggestive Readings:

- Hogg, R.V. and Tanis, E.A. (2009). A Brief Course in Mathematical Statistics. Pearson Education.
- Johnson, R.A. and Bhattacharya, G.K. (2001). Statistics-Principles and Methods, 4th Ed., John Wiley and Sons.
- Mood, M.A., Graybill, F.A. and Boes, C.D. (2007). Introduction to the Theory of Statistics, 3rd Ed., (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

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COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

OFFERED BY DEPARTMENT OF STATISTICS

CATEGORY-IV

GENERIC ELECTIVES – 3A: SAMPLING DISTRIBUTIONS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sampling Distributions	4	3	0	1	Part I and II	DSC-1 and 3

Learning Objectives:

The learning objectives include:

- To understand the concept of sampling distributions and their applications in statistical inference.
- To understand the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Learning Outcomes:

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

- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Hypothesis testing based on a single sample and two samples using both classical and p value approach.
- Chi square distribution.
- Analyze categorical data by using Chi square techniques.
- t and F distributions and their applications.

SYLLABUS OF GE-3A

Theory

Unit I **(15 hours)**

Large sample tests

Large sample tests: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value

approaches.

Unit II **(15 hours)**

Chi square distribution

Chi square distribution: Definition and derivation of $\chi 2$ distribution with n degrees of freedom (d.f.) using m.g.f., nature of probability curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of $\chi 2$ distribution. Tests of significance and confidence intervals based on $\chi 2$ distribution.

Unit III **(15 hours)**

Exact Sampling Distributions

t and F distributions: Student's t and Fishers t-distributions, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of F distribution, nature of probability curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1,n_2)$. Relationship between t, F and $\chi 2$ distributions. Test of significance and confidence intervals based on t and F distributions.

PRACTICAL/LAB WORK - 30 hours

List of Practicals

1. Large Sample Tests:
   g) Testing of significance and confidence intervals for single proportion and difference of two proportions.
   h) Testing of significance and confidence intervals for single mean and difference of two means.
   i) Testing of significance and confidence intervals for difference of two standard deviations.

2. Tests based on Chi-Square Distribution:
   i) To test if the population variance has a specific value and its confidence intervals.
   j) To test the goodness of fit.
   k) To test the independence of attributes.
   l) Test based on 2 x 2 contingency table without and with Yates' corrections.

3. Tests based on t- Distribution and F- Distribution:
   g) Testing of significance and confidence intervals for single mean and difference of two means and paired t – test.
   h) Testing of significance and confidence intervals of an observed sample correlation coefficient.
   i) Testing and confidence intervals of equality of two population variances.

ESSENTIAL READINGS :

- Gupta, S. C. and Kapoor, V. K. (2020). Fundamentals of Mathematical Statistics, 12th Ed., S. Chand and Sons. Delhi.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). An Outline of Statistical Theory, Vol. I, 4th Ed., World Press, Kolkata.
- Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). An Introduction to Probability and Statistics, 2nd Ed., (Reprint) John Wiley and Sons.

SUGGESTIVE READINGS:

- Hogg, R.V. and Tanis, E.A. (2009). A Brief Course in Mathematical Statistics. Pearson Education.
- Johnson, R.A. and Bhattacharya, G.K. (2001). Statistics-Principles and Methods, 4th Ed., John Wiley and Sons.
- Mood, M.A., Graybill, F.A. and Boes, C.D. (2007). Introduction to the Theory of Statistics, 3rd Ed., (Reprint).Tata McGraw-Hill Pub. Co. Ltd.

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GENERIC ELECTIVES – 3B: PSYCHOLOGICAL AND EDUCATIONAL STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Psychological and Educational Statistics	4	3	0	1	Basic knowledge of Statistics	

Learning Objectives:

- To learn some scaling procedures used in Psychology and Education to give raw scores a more meaningful interpretation.
- To check the reliability and validity of test scores.
- To understand the features of Ability Testing.

Learning Outcomes:

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

- The distinction between Psychological measurement and physical measurement.
- Meaning of Test in Psychology and Education.
- Uses and limitations of Psychological tests.
- Meaning and purpose of Item writing and analysis.
- Understanding concepts of reliability and validity of test scores and their differences.
- Converting raw scores into different transformed scores.
- Scaling rankings and ratings in terms of Normal Probability Curve.
- Concepts of Ability Testing.

Contents

Unit-I **(16 hours)**

Scaling Procedures in Psychological Testing

Introduction; need and importance of statistics in psychology and education. Different types of scales and distinction between a psychological scale and a physical scale.

Some scaling procedures used in Psychology– Scaling of Individual test items in terms of difficulty, Scaling of test scores in different tests: z-scaling, percentile scaling, T-scaling, standard scores, normalized standard scores, Equivalent-scores, and Stanine scores and inter comparisons. Scaling of rankings & ratings in terms of the normal probability curve.

Unit-II **(16 hours)**

Test Theory

Test Theory: Linear model of test theory. Norms and reference groups. Parallel tests, Speed and Power tests. Definition of true score, Standard error of measurements.

Reliability of test scores: definition of reliability, Index of reliability, Effect of test length on the reliability of a test. Methods of estimating test reliability.

Validity of test scores: Meaning, types of validity; Predictive, Content, Concurrent and construct validity. Validity and test length, relation of validity to reliability.

Unit-III **(13 hours)**

Ability Testing

Individual tests: The Wechsler scale. Intelligence: Definition. Types of intelligence test scores. Spearman's two-factor theory and Thomson group factors theory. Psychological issues in ability testing.

PRACTICAL/LAB WORK – (30 hours)

List of Practical

1. Converting raw scores into Z-scores, T-scores, Percentile-scores, Normalized Standard scores, Equivalent scores and Stanine scores.
2. Calculation of T scores for a given frequency distribution
3. Calculation of percentile scores corresponding to rank of an individual among N individuals
4. Computation of numerical scores corresponding to grades/ratings given by different judges.
5. Computation of Reliability by Rulon and Kuder Richardson Formulas.
6. Finding reliability of a test whose length is increased/ decreased *n* times.
7. Finding index of reliability, standard error of measurement.
8. Finding validity/maximum validity when test length is increased *n* times/ indefinitely.
9. Finding relative difficulty of questions/ difference in difficulty between different tests.

Essential Readings:

- Kevin R. Murphy, Charles O. Davidshofer (2004) - Psychological Testing Principles and Applications, Prentice Hall.
- Anastasi A. & Urbina S. (1997). Psychological testing (7th ed.). Prentice Hall.
- Garrett H. E. (2021). Statistics in psychology and education. Nation Press.

Suggested Readings:

- Gregory R. J. (2016). Psychological testing: History Principles and Applications. (Updated seventh). Pearson.
- Singh, A. K. (2006). Tests, Measurements and Research in Behavioural Sciences. Bharati Bhavan.
- Mangal, S. K. (2016). Statistics in Psychology and Education. PHI Learning Pvt. Ltd..
- Gupta, S. C., & Kapoor, V. K. (2019). Fundamentals of applied statistics. Sultan Chand & Sons.
- Goon A.M., Gupta M.K. & Dasgupta B. (2001). Fundamentals of Statistics, Volume 2. The World Press Pvt.Ltd.

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Discipline Specific Elective

Category-V

Discipline Specific Elective for B. Sc. (H) Statistics

DISCIPLINE SPECIFIC ELECTIVE COURSE – 1A: OPERATIONAL RESEARCH

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Operational Research	4	3	0	1	**Class XII with Mathematics**	**….**

Learning Objectives:

The learning objectives include:

- To create awareness about the term operational research (OR) and acquaint them with the methodologies, scope, limitations and applications of OR and
- To expose the students with the knowledge of formulation of real life problems using the linear programming method.
- To make the students understand about the theory and practical application of transportation problems and assignment problems
- To introduce 'Game Theory-the science of strategy' to the students, which makes possible the analysis of the decision making process of interdependent subjects.
- To provide a framework to develop mathematical models for different types inventory systems.

Learning Outcomes:

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

- The fundamental concepts of Operational Research Techniques
- Linear Programming.
- Transportation and assignment problems

- Game Theory
- Inventory Models

SYLLABUS OF DSE-1A

Theory

UNIT I **(15 hours)**

Introduction to OR and LPP

Definition and phases of O.R. Model building, various types of O.R. problems. Linear Programming Problem (L.P.P.): Mathematical formulation of the L.P.P, graphical solutions of L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P. Economic interpretation of Duality. Dual simplex method.

UNIT II **(15 hours)**

Transportation and Assignment Problem

Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem. Assignment problem: Hungarian method to find optimal assignment, special cases of assignment problem.

UNIT III **(15 hours)**

Game Theory and Inventory Management

Game theory: Rectangular game, minimax - maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy. Network flow problems and shortest route problem. Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations, with and without shortages.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Mathematical formulation of L.P.P and solving the problem using graphical method.
2. Simplex technique and Charne's Big M method involving artificial variables.
3. Identifying Special cases by Graphical and Simplex method and interpretation:
   a) Degenerate solution
   b) Unbounded solution
   c) Alternate solution
   d) Infeasible solution
4. Allocation problem using Transportation model.
5. Allocation problem using Assignment model.
6. Graphical solution to mx2 / 2xn rectangular game
7. Mixed strategy
8. To find optimal inventory policy for EOQ models and its variations.

(Using TORA/WINQSB/LINGO/EXCEL)

Essential Readings:

- Taha, H. A. (2007). Operations Research: An Introduction, 8thEd., Prentice Hall of India.
- Swarup, K., Gupta, P.K. and Man Mohan (2013). Operations Research, 16th Ed., Sultan Chand and Sons.

Suggestive Readings:

- G. Hadley (2002). Linear Programming, Reprint.
- A. Ravindran, D. T. Phillips and James J. Solberg(2005). Operations Research- Principles and Practice, John Wiley & Sons,
- F.S. Hillier. G.J. Lieberman (2010). Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata McGraw Hill.
- Donald Waters (2010): Inventory Control and Management, John Wiley.

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DISCIPLINE SPECIFIC ELECTIVE COURSE – 1B: PSYCHOLOGICAL AND EDUCATIONAL STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Psychological and Educational Statistics	4	3	0	1		DSC-1 and 3

Learning Objectives:

The learning objectives include:

- To measure psychological traits and mental abilities
- To learn basic methods of test construction, item writing and item analysis
- To check the reliability and validity of test scores.

Learning Outcomes:

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

- The distinction between Psychological measurement and physical measurement.
- Meaning of Test in Psychology and Education.
- Uses and limitations of Psychological tests.
- Meaning and purpose of Item writing and analysis.
- Understanding concepts of reliability and validity of test scores and their differences.
- Converting raw scores into different transformed scores.
- Scaling rankings and ratings in terms of Normal Probability Curve

SYLLABUS OF DSE-1B

Theory

Unit I **(15 hours)**

Basics of Educational Statistics

Introduction; need and importance of statistics in psychology and education. Measurements: Levels of measurements. Distinction between psychological and physical measurements; general problems, sources of errors. Tests: Meaning of tests in psychology and education; history of psychological measurement and testing, uses, limitations and varieties, characteristics of a good test, general steps of test construction. Test administration. Item writing - Meaning and types; Item analysis – meaning and purpose. Item difficulty (concepts only). Power tests and speed tests.

Unit II **(15 hours)**

Reliability and Validity

Reliability: Meaning, methods (or types); standard error of measurement, reliability of speed test, factors influencing reliability of test scores, factors for their improvement, estimation of true scores and index of reliability. Reliability of difference and composite scores. Validity: Meaning; content, criterion related and construct validity. Statistical methods for calculating validity, factors influencing validity. Extra validity concerns, relation of validity to reliability.

Unit III **(15 hours)**

Psychological Statistics

Meaning of norm referencing and criterion referencing. Raw score transformations-percentile score, standard scores, normalized standard scores, T-scores, C-scores and Stanine scores. Intelligence: Definition. Types of intelligence test scores. Spearman's two-factor theory and Thomson group factors theory. Psychological scaling methods – Scaling of Individual test items in terms of difficulty, scaling of rankings & ratings in terms of the normal probability curve.

PRACTICAL/LAB WORK - 30 hours

List of Practical:

1. Computation of Reliability by Rulon and Kuder Richardson Formulas.
2. Finding reliability of a test whose length is increased/ decreased n times.
3. Finding index of reliability, standard error of measurement.
4. Finding validity/maximum validity when test length is increased n times/ indefinitely.
5. Finding relative difficulty of questions/ difference in difficulty between different tests.
6. Converting raw scores into Z-scores.
7. Converting raw scores into T-scores.
8. Calculation of T scores for a given frequency distribution.
9. Construction of C-scales and its diagrammatic representation.
10. Construction of Stanine-scales and its diagrammatic representation.
11. Calculation of percentile scores corresponding to rank of an individual among N individuals.
12. Finding numerical scores corresponding to grades or ratings by different judges.

(Using EXCEL/SPSS)

ESSENTIAL READINGS:

- Anastasi A. & Urbina S. (1997). Psychological testing (7th ed.). Prentice Hall.
- Garrett H. E. (2021). Statistics in psychology and education. Nation Press.
- Gregory R. J. (2016). Psychological testing: History Principles and Applications. (Updated seventh). Pearson.
- Singh, A. K. (2006). Tests, Measurements and Research in Behavioural Sciences. Bharati Bhavan.

SUGGESTIVE READINGS:

- Mangal, S. K. (2016). Statistics in Psychology and Education. PHI Learning Pvt. Ltd..
- Gupta, S. C., & Kapoor, V. K. (2019). Fundamentals of applied statistics. Sultan Chand & Sons.
- Goon A.M., Gupta M.K. & Dasgupta B. (2001). Fundamentals of Statistics, Volume 2. The World Press Pvt.Ltd.

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Discipline Specific Elective for B. Sc. (P)

DISCIPLINE SPECIFIC ELECTIVE COURSE – 1: TIME SERIES ANALYSIS AND INDEX NUMBERS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Time Series Analysis and Index Numbers	4	3	0	1	Basic knowledge of Statistics	NIL	Statistics

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce the concept of time series, its components, and their estimation.
- Introduce the application of time series.
- Introduce the concept, formulation, and application of index numbers.

Learning outcomes

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

- Understand the concepts of time series and index numbers.
- Formulate, solve, and analyze the use of time series and index numbers for real-world problems.

SYLLABUS OF DSE 1

Theory

Unit - 1 **(12 hours)**

Components of Time Series

Introduction to Time Series, Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series, Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and exponential).

Unit - 2 **(12 hours)**

Trend and Seasonality

Fitting of modified exponential, Gompertz and logistic curve, Moving average method, Measurement of seasonal variations by method of simple averages, ratio to trend method, and ratio to moving average method.

Unit - III **(18 hours)**

Index Numbers

Introduction to Index numbers, Problems in the construction of index numbers, Construction of price and quantity index numbers: simple aggregate, weighted aggregate (Laspeyres, Paasche's, Drobish-Bowley, Marshall-Edgeworth's, Walsch and Fisher's Formula), simple and weighted average of price relatives, and chain base method, Criteria for a good index number, Errors in the measurement of price and quantity index numbers, Consumer price index number, its construction and uses, Uses and limitations of index numbers.

Practical - 30 Hours

List of Practicals:

1. Fitting of linear trend
2. Fitting of quadratic trend
3. Fitting of an exponential curve
4. Fitting of modified exponential curve by the method of
    a. Three selected points
    b. Partial sums
5. Fitting of Gompertz curve by the method of
    a. Three selected points
    b. Partial sums
6. Fitting of logistic curve by the method of three selected points
7. Fitting of trend by moving average method (for n even and odd)
8. Measurement of seasonal indices by
    a. Method of simple averages
    b. Ratio-to-trend method
    c. Ratio-to-moving-average method
9. Construction of price and quantity index numbers by simple aggregate method.
10. Construction of price and quantity index numbers by Laspeyres, Paasche's, Drobish-Bowley, Marshall-Edgeworth, Walsch and Fisher's Formula.

11. Construction of price and quantity index numbers by simple and weighted average of price relatives.
12. Construction of index number by Chain base method.
13. Construction of consumer price index number by
    a. Family budget method
    b. Aggregate expenditure method
14. Time Reversal Test and Factor Reversal Test

Essential Readings

- Croxton, Fredrick E, Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd edition, Prentice Hall of India Pvt. Ltd.
- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008). Fundamentals of Statistics, Vol. II, 9th Ed., World Press, Kolkata.
- Gupta, S.C. and Kapoor, V.K. (2014). Applied Statistics, 11th Ed., Sultan Chand.

Suggestive Reading

- Allen R.G.D. (1975): Index Numbers in Theory and Practice, Macmillan
- Mukhopadhyay, P. (1999). Applied Statistics, New Central Book Agency, Calcutta.

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