

SYLLABUS

GOLAGHAT COMMERCE COLLEGE (AUTONOMOUS)
FOUR YEARS UNDER GRADUATE PROGRAMME (FYUGP)
[AS PER NEP 2020]



STATISTICS

(Recommended by B.O.S. in Statistics, in the meeting held on 19.05.2025)

PROGRAM OUTCOMES (POs)

PO1: Graduates will demonstrate a strong understanding of fundamental statistical concepts, theories, and methodologies.

PO2: Graduates will be proficient in collecting, cleaning, analyzing, and interpreting data using statistical software and techniques.

PO3: Graduates will possess a solid foundation in mathematical concepts and techniques relevant to statistics, including calculus, linear algebra, and probability theory.

PO4: Graduates will be competent in using statistical software packages such as R, Python, or SPSS to conduct data analysis and visualization.

PO5: Graduates will be able to design experiments, surveys, and observational studies to address research questions and hypotheses effectively.

PO6: Graduates will understand and apply inferential statistical methods such as hypothesis testing, confidence intervals, regression analysis, and analysis of variance.

PO7: Graduates will have knowledge of advanced statistical techniques for analyzing complex datasets with multiple variables, including multivariate analysis, factor analysis, and cluster analysis.

PO8: Graduates will be proficient in analyzing time-series data and forecasting future trends using appropriate statistical models and techniques.

PO9: Graduates will be able to communicate statistical findings effectively to diverse audiences through written reports, oral presentations, and data visualization.

PO10: Graduates will demonstrate critical thinking skills and the ability to apply statistical reasoning to solve real-world problems in various domains.

PO11: Graduates will understand the ethical principles and guidelines governing the conduct of statistical research and practice, including issues related to confidentiality, data integrity, and bias.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 1st SEMESTER**

Title of the Course: Statistical Methods

Code: STAMAJ1

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	Basic Statistics: Definition and scope of Statistics, Limitations of Statistics, concepts of statistical population and sample. Statistical investigation and Types of Data: Planning and execution stages, quantitative and qualitative data, primary and secondary data, Schedules and Questionnaire, Census Vs Sampling and their merits and demerits. Tabulation and Presentation of Data: Tabulation and graphical representation (Pie Chart, Histogram, Frequency Polygon, Frequency Curve , Ogives)	07	01	-	08
II (10 Marks)	Measures of Central Tendency: Mathematical averages including arithmetic mean, geometric mean, harmonic mean, Properties and applications. Positional averages: Median, Mode (other partition values including quartiles, deciles and percentiles)	08	02	-	10
III (15 Marks)	Measures of Dispersion: Range, quartile deviation, mean deviation, standard deviation, Properties of standard deviation/ variance, coefficient of variation, moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections .	10	02		12
IV (15 Marks)	Simple Correlation and Regression Analysis: Correlation Analysis: Meaning of Correlation: simple, multiple, partial, linear, non-linear, scatter diagram, interpretation of r and rank correlation. Regression analysis: Simple linear regression, Principles of least squares and regression lines, Regression equations and estimation, properties of regression coefficients, Relation between correlation and regression, fitting of polynomials and exponential curves. Multivariate Data: Definition, partial and multiple correlation, interpretation of R, and coefficient of determination.	12	02		14

V (10 Marks)	List of Practical: (both calculator and computerbased) 1. Graphical representation of data. 2. Problems based on measures of central tendency. 3. Problems based on measures of dispersion. 4. Problems based on combined mean and variance and coefficient of variation. 5. Problems based on moments, skewness and kurtosis 6. Fitting of polynomials, exponential curves. 7. Karl Pearson correlation coefficient. 8. Spearman rank correlation with and without ties. 9. Partial and multiple correlations. 10. Correlation coefficient for a bivariate frequency distribution.			8	16
	Total	37	7	8	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edition. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edition), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edition, (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Barman. M. P., Hazarika. J, Bora. T (2021): Statistical Methods, Mahaveer Pub, Dibrugarh.
5. Elhance, D. N., Elhance, V., and Aggarwal, B. M. (1958). Fundamentals of Statistics, Allahabad. Kitab Mahal.
6. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 1st SEMESTER**

Title of the Course: Statistical Methods

Code: STAMIN1

Nature of the Course: Minor

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	Basic Statistics: Definition and scope of Statistics, Limitations of Statistics, concepts of statistical population and sample. Statistical investigation and Types of Data: Planning and execution stages, quantitative and qualitative data, primary and secondary data, Schedules and Questionnaire, Census Vs Sampling and their merits and demerits. Tabulation and Presentation of Data: Tabulation and graphical representation (Pie Chart, Histogram, Frequency Polygon, Frequency Curve , Ogives)	07	01	-	08
II (10 Marks)	Measures of Central Tendency: Mathematical averages including arithmetic mean, geometric mean, harmonic mean, Properties and applications. Positional averages: Median, Mode (other partition values including quartiles, deciles and percentiles)	08	02	-	10
III (15 Marks)	Measures of Dispersion: Range, quartile deviation, mean deviation, standard deviation, Properties of standard deviation/ variance, coefficient of variation, moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections .	10	02		12
IV (15 Marks)	Simple Correlation and Regression Analysis: Correlation Analysis: Meaning of Correlation: simple, multiple, partial, linear, non-linear, scatter diagram, interpretation of r and rank correlation. Regression analysis: Simple linear regression, Principles of least squares and regression lines, Regression equations and estimation, properties of regression coefficients, Relation between correlation and regression, fitting of polynomials and exponential curves. Multivariate Data: Definition, partial and multiple correlation, interpretation of R, and coefficient of determination.	12	02		14

V (10 Marks)	List of Practical: (both calculator and computerbased) 1. Graphical representation of data. 2. Problems based on measures of central tendency. 3. Problems based on measures of dispersion. 4. Problems based on combined mean and variance and coefficient of variation. 5. Problems based on moments, skewness and kurtosis 6. Fitting of polynomials, exponential curves. 7. Karl Pearson correlation coefficient. 8. Spearman rank correlation with and without ties. 9. Partial and multiple correlations. 10. Correlation coefficient for a bivariate frequency distribution.			8	16
	Total	37	7	8	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

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1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edition. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edition), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edition, (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Barman. M. P., Hazarika. J, Bora. T (2021): Statistical Methods, Mahaveer Pub, Dibrugarh.
5. Elhance, D. N., Elhance, V., and Aggarwal, B. M. (1958). Fundamentals of Statistics, Allahabad. Kitab Mahal.
6. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 2ND SEMESTER**

Title of the Course: Basic Probability Theory and Statistical Distributions

Code: STAMAJ2

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (10 Marks)	Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of probability – classical, statistical, and axiomatic. Conditional probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes’ theorem and its applications.	08	01	-	09
2 (15 Marks)	Random variables: Discrete and continuous random variables, pmf, pdf and cdf, illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: Discrete and continuous type, joint, marginal and conditional pmf, pdf, and cdf, independence of variables, bivariate transformations with illustrations. Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.	10	01	-	11
3 (10 Marks)	Convergence in Probability: Idea of convergence in probability, Chebyshev’s inequality, weak law of large numbers, De Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.) (statement only without proof)	09	02	-	11
4 (15 Marks)	Standard Probability Distributions: Binomial, Poisson, Geometric, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.	11	02	-	13
5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Fitting of binomial distribution. 2. Fitting of Poisson distribution. 3. Fitting of geometric distribution. 4. To find the ordinate for a given area for normal	-	-	08	16

	distribution. 5. Fitting of normal distribution. 6. Fitting of exponential distribution.				
	Total	38	06	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Hogg, R. V., Tanis, E. A. and Rao J. M. (2009): Probability and Statistical Inference, 17th edition, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th edition), Pearson Education, Asia.
3. Myer, P. L. (1970): Introductory Probability and Statistical Applications, Oxford & IBHPublishing, New Delhi.
4. Kakaty, S. C.(2003). Mathematical Statistics: Theory and Applications, KaustubhPrakashan, Dibrugarh.
5. Ross, S. M. (2014). Introduction to probability models. Academic Press Inc.
6. Johnson, R. A., Miller, I., and Freund, J. E. (2000). Probability and statistics for engineers.6th Edition, Pearson Education India.
9. Elhance, D. N., Elhance, V., and Aggarwal, B. M. (1958). Fundamentals of Statistics,Allahabad. Kitab Mahal.
10. Rohatgi, V. K., Saleh, A. K. M. E. (2011). An Introduction to Probability andStatistics. Germany: Wiley.
11. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 2ND SEMESTER**

Title of the Course: Introductory Probability

Code: STAMIN2

Nature of the Course: Minor

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (10 Marks)	Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of probability – classical, statistical, and axiomatic. Conditional probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.	08	01	-	09
2 (15 Marks)	Random variables: Discrete and continuous random variables, pmf, pdf and cdf, illustrations and properties of random variables, univariate transformations with illustrations, Two dimensional random variables: Discrete and continuous type, joint, marginal and conditional pmf, pdf, and cdf, independence of variables, bivariate transformations with illustrations. Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.	10	01	-	11
3 (10 Marks)	Convergence in Probability: Idea of convergence in probability, Chebyshev's inequality, weak law of large numbers, De Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.) (statement only without proof)	09	02	-	11
4 (15 Marks)	Standard Probability Distributions: Binomial, Poisson, geometric, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.	11	02	-	13
5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Fitting of binomial distribution. 2. Fitting of Poisson distribution. 3. Fitting of geometric distribution. 4. To find the ordinate for a given area for normal distribution.	-	-	08	16

	5. Fitting of normal distribution. 6. Fitting of exponential distribution.				
	Total	38	06	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Hogg, R. V., Tanis, E. A. and Rao J. M. (2009): Probability and Statistical Inference, 17th edition, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th edition), Pearson Education, Asia.
3. Myer, P. L. (1970): Introductory Probability and Statistical Applications, Oxford & IBHPublishing, New Delhi.
4. Kakaty, S. C.(2003). Mathematical Statistics: Theory and Applications, KaustubhPrakashan, Dibrugarh.
5. Ross, S. M. (2014). Introduction to probability models. Academic Press Inc.
6. Johnson, R. A., Miller, I., and Freund, J. E. (2000). Probability and statistics for engineers.6th Edition, Pearson Education India.
7. Elhance, D. N., Elhance, V., and Aggarwal, B. M. (1958). Fundamentals of Statistics,Allahabad. Kitab Mahal.
8. Rohatgi, V. K., Saleh, A. K. M. E. (2011). An Introduction to Probability andStatistics. Germany: Wiley.
9. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 3rd SEMESTER**

Title of the Course: Sampling Distributions 1

Code: STAMAJ3A

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 Marks)	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's. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers, tests of adequacy of Index Numbers, inflation(Core and Headline).	09	02	-	11
2 (14 Marks)	Sampling Distribution: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Testing of Hypotheses: 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.	10	02	-	12
3 (12 Marks)	Exact Sampling Distribution: Definition and derivation of pdf of χ^2 with n degrees of freedom (df) using mgf, nature of pdf curve for different degrees of freedom, mean, variance, mgf, cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on distribution.	09	01	-	10
4 (12 Marks)	Student's t-Distributions: Student's and Fishers t-distribution, Derivation of its pdf, nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F-Distribution: Derivation of pdf, nature of pdf curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.	09	02	-	11

5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Testing of significance, and construction of confidence intervals for proportion. 2. Testing of significance, and construction of confidence intervals for single mean and difference of two means and paired tests. 3. Testing of significance, and construction of confidence intervals for difference of two standard deviations. 4. Exact sample tests based on chi-square distribution. 5. Testing of significance when the population variance has a specific value and its confidence intervals. 6. Testing of goodness of fit. 7. Testing of independence of attributes. 8. Testing based on 2×2 contingency table without and with Yates' corrections. 9. Testing of significance of an observed sample correlation coefficient . Testing and confidence intervals of equality of two population variances 8. Calculate price and quantity index numbers using simple and weighted average of price relatives. 9. To calculate the chain base index numbers. 10. To calculate consumer price index number.	-	-	08	16
	Total	37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.I, 4th edition World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd edition (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in

- Mathematical Statistics. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th edition John Wiley and Sons.
 5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd edition (Reprint). Tata McGraw-Hill Pub. Co. Ltd.
 6. Kakaty, S. C.(2003). Mathematical Statistics: Theory and Applications, KaustubhPrakashan, Dibrugarh
 7. Rohatgi, V. K., Saleh, A. K. M. E. (2011). An Introduction to Probability and Statistics. Germany: Wiley.
 8. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
 9. Goon A. M., Gupta M. K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edition. The World Press, Kolkata.
 10. S.C. Gupta, V.K. Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 3rd SEMESTER**

Title of the Course: Basic Mathematical Analysis

Code: STAMAJ3B

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	Real Analysis: Real Numbers. Bounded and unbounded sets, neighborhoods and limit points, Suprimum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences. Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences.	11	02	-	13
2 (10 Marks)	Series Analysis: Infinite series, positive termed series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence.	07	02	-	09
3 (10 Marks)	Determinants and Matrices: Algebra of matrices and determinants. Types of Matrices: triangular, symmetric and skew symmetric matrices, idempotent matrices, orthogonal matrices, singular and non-singular matrices related results and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices.	08	01	-	09
4 (15 Marks)	Vector Space: Definition, properties, basis, dimension, span, linear dependency. Matrix Operations: Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse (concept with illustrations). Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, useful Properties of characteristic roots, Cayley-Hamilton theorem, Quadratic forms definition and classifications; Linear orthogonal transformation.	11	02	-	13

5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Problems related to linearly independence and dependence. 2. Determination of rank of a matrix of order 4x4. 3. Inverse of a matrix of order 4x4. 4. Solution of system of equations. 5. Problems related to quadratic forms. 6. Determination of eigen values and vectors. 7. Classification of quadratic form with eigen value.	-	-	08	16
Total		37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Malik S.C. and Savita Arora, (1994): Mathematical Analysis, Second Edition, WileyEastern Limited, New Age International Limited, New Delhi.
2. Somasundram D. and Chaudhary B. (1987): A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
3. Gupta S.L. and Nisha Rani, (1995): Principles of Real Analysis, Vikas Publ. House Pvt.Ltd., New Delhi.
4. Appostol T.M. (1987): Mathematical Analysis, 2nd edition, Narosa Publishing House, New Delhi.
5. Shanti Narayan, (1987): A course of Mathematical Analysis, 12th revised edition, S.Chand & Co. (Pvt.) Ltd., New Delhi.
6. Singal M.K. and Singal A.R., (2003): A First Course in Real Analysis, 24th edition, R.Chand & Co., New Delhi.
7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd edition), JohnWiley and Sons (Asia) Pte. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
9. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation. New age International Publisher, India.
10. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
11. Schaum's Outlines: Linear Algebra, Tata McGraw-Hill Edition, 3rd edition,

- 2006.
12. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II,III, IV, V).
 13. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
 14. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
 15. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
 16. Artin M.: Algebra. Prentice Hall of India, 1994.
 17. Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
 18. Hadley G.: Linear Algebra. Narosa Publishing House (Reprint), 2002.
 19. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 3rd SEMESTER**

Title of the Course: Statistical Inference

Code: STAMIN3

Nature of the Course: Minor

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 Marks)	Sampling Distributions: Chi-square, t and F (assumption, properties and applications)	09	01	-	10
2 (14 Marks)	Estimation: Concepts of estimation, unbiasedness, consistency, efficiency and sufficiency. Factorization theorem(without proof). Minimum variance unbiased estimator (MVUE). Methods of Estimation: Method of moments, method of maximum likelihood estimation.	10	02	-	12
3 (12 Marks)	Testing of Hypothesis: Critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).	09	02	-	11
4 (12 Marks)	Sequential Analysis: Sequential probability ratio test (SPRT). Fundamental relations among α , β , A and B, determination of A and B in practice. Wald's fundamental identity (sans proof) and concept of operating characteristics (OC) and Average Sample Number (ASN) functions, example based on normal distribution.	09	02	-	11
5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Maximum likelihood estimators for the exponential, normal distributions. 2. Estimation by method of moments for the binomial, Poisson, normal distributions. 3. Drawing power curves for the tests of equality of normal mean (s). 4. Likelihood ratio test: Single-sample and two-sample testing problems. 5. Sequential testing procedure: Construction of OC, ASN function and drawing of OC, ASN curve.	-	-	08	16
	Total	37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:**(40 Marks)**

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.I, 4th edition World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd edition (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th edition John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd edition (Reprint). Tata McGraw-Hill Pub. Co. Ltd.
6. Kakaty, S. C. (2003). Mathematical Statistics: Theory and Applications, Kaustubh Prakashan, Dibrugarh
7. Rohatgi, V. K., Saleh, A. K. M. E. (2011). An Introduction to Probability and Statistics. Germany: Wiley.
8. S.C. Gupta, V.K. Kapoor (2020): Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
9. Goon A. M., Gupta M. K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edition. The World Press, Kolkata.
10. S.C. Gupta, V.K. Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand & Sons.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 4th SEMESTER**

Title of the Course: Statistical Quality Control

Code: STAMAJ4A

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (14 Marks)	Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from world war II, Quality System and Standards: Introduction to ISO quality standards, Quality registration. Statistical process control - seven tools of SPC, chance and assignable causes of quality variation. Statistical Control charts- construction and statistical basis of 3- σ control charts, rational sub-grouping.	11	02	-	13
2 (14 Marks)	Control Charts: For variables- X-bar and R-chart & s-chart. 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.	10	02	-	12
3 (14) Marks)	Acceptance Sampling Plan: Principle of acceptance sampling plans. Single and double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.	09	02	-	11
4 (8 Marks)	Introduction to Six-Sigma: Overview of six sigma, lean manufacturing and Total Quality Management (TQM). Organizational structure and six sigma training plans- selection criteria for six-sigma roles and training plans. Voice of Customers (VOC): Importance and VOC data collection. Critical to quality (CTQ).	07	01		08
5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Construction and interpretation of statistical control charts: Variable charts- X-bar, R-chart & s-chart. Attribute charts- np-chart, p-chart, c-chart, & u-chart. 2. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves. 3. Calculation of process capability and comparison of 3-sigma control limits with specification limits.	-	-	08	16
	Total	37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READING:

1. Montgomery, D. C.: Introduction to Statistical Quality Control, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B.: Fundamentals of Statistics, Vol. II, The WorldPress, Kolkata.
3. Mukhopadhyay, P: Applied Statistics, Books and Allied (P) Ltd.
4. Montgomery, D. C. and Runger, G.C.: Applied Statistics and Probability for Engineers, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris: Transactional Six Sigma and Lean Servicing, St. Lucie Press.
6. Hoyle, David: ISO Quality Systems Handbook, Butterworth Heinemann Publication.
7. S.C. Gupta, V.K. Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand & Sons.

FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course: Statistical Inference- I

Code: STAMAJ4B

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 Marks)	Basic Concepts: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications).	09	02	-	11
2 (10 Marks)	Methods of Estimation: Method of moments, method of maximum likelihood, method of minimum Chi-square (properties and examples). Least squares method.	08	01	-	09
3 (15 Marks)	Testing of Hypothesis: Critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).	11	02	-	13
4 (13 Marks)	Sequential Analysis: Sequential probability ratio test (SPRT) for simple null vs. simple alternative hypotheses. Fundamental relations among α , β , A and B, determination of A and B in practice. Wald's fundamental identity (sans proof) and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.	09	02		11
5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Maximum likelihood estimators. 2. Estimation by method of moments for the binomial, Poisson, exponential, normal distributions. 3. Comparison of method of moments and maximum likelihood estimators for the continuous uniform distribution. 4. Computation of Type- I and Type-II errors. 5. Application of NP lemma: construction of MP and UMP tests. 6. Drawing power curves for the tests of equality of normal mean (s).	-	-	08	16

	7. Likelihood ratio test: Single-sample and two-sample testing problems. Sequential testing procedure: Construction of OC, ASN function and drawing of OC, ASN curve.				
	Total	37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READING:

1. Goon A.M., Gupta M.K.: Das Gupta. B. (2005), Fundamentals of Statistics, Vol. I, WorldPress, Calcutta.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd edition (Reprint) John Wiley and Sons.
3. Miller, I. and Miller, M. (2002): John E. Freund's Mathematical Statistics (6th edition, low price edition), Prentice Hall of India.
4. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
5. Mood A.M, Graybill F.A. and Boes D.C.: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor G.W and Cochran W.G. (1967) Statistical Methods. Iowa State University Press.
8. McColl, J. H. (2004). Multivariate probability. John Wiley and Sons.
9. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, 17th edition, Pearson Education, New Delhi.
10. Ross, S. M. (2014). Introduction to probability models. Academic Press Inc.
11. Johnson, R. A., Miller, I., and Freund, J. E. (2000). Probability and statistics forengineers. 6th Edition, Pearson Education India.

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 4th SEMESTER**

Title of the Course: Sample Survey and Indian Official Statistics

Code: STAMAJ4C

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (13 Marks)	Introduction to Sample Survey: Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.	10	02	-	12
2 (15 Marks)	Stratified Random Sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=nk$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections. Cluster Sampling: Technique, estimation of population mean and its variance.	13	02	-	15
3 (12 Marks)	Ratio and Regression Estimators: Concepts, first approximation to the population mean and total (for SRS of large size), variances of these estimators and estimators of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS.	10	01	-	11
4 (10 Marks)	Official Statistics : Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.	05	01	-	06

5 (10 Marks)	List of Practical: (both calculator and computer based) 1. Simple random sampling: Drawing of a random numbers by with replacement method (SRSWR) and without replacement method (SRSWOR). 2. Enumeration of all possible samples in SRSWR, SRSWOR and establish properties. 3. Calculations of population mean, mean square and variance. Estimation of mean, standard error. 4. Stratified Sampling: Allocation of sample to strata by proportional and Neyman's methods. Also, compare their efficiencies relative to SRS. 5. Estimation of gain in precision in stratified sampling. 6. Systematic sampling: Comparison of systematic 7. Estimation of gain in precision in stratified sampling. 8. Systematic sampling: Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend. 9. Ratio and regression estimation: Calculation of population mean or population total. Calculation of mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS. 10. Cluster sampling: Estimation of mean or total, variance of the estimate	-	-	08	16
Total		38	06	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READINGS:

1. Cochran W. G. (1984): Sampling Techniques (3rd edition), Wiley Eastern.
2. 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.
3. Murthy M. N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House. New Delhi.
5. Goon A. M., Gupta M. K. and Dasgupta B. (2001): Fundamentals of

- Statistics (Vol.2), World Press.
6. Ladusingh L. (2018): Survey Sampling Methods, PHI Learning Private Limited.
 7. S.C. Gupta, V.K. Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand & Sons.

FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course: Statistical Computing Using C Programming

Code: STAMAJ4D

Nature of the Course: Major

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	<p>Introduction to C: History and importance of C, Components, basic structure programming, character set, C tokens, Keywords and Identifiers and execution of a C program.</p> <p>Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables,</p> <p>Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions.</p> <p>Managing input and output operations: reading and printing formatted and unformatted data.</p>	12	02	-	14
2 (12 Marks)	<p>Decision Making and Branching: if...else, nesting of if...else, else if ladder, switch, conditional operator. Looping in C for, nested for, while, do...while, jumps in and out of loops.</p> <p>Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings:</p>	10	02	-	12

3 (12 Marks)	User-Defined Functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions: no arguments and no return values, arguments but no return values, arguments with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of variables.	10	02		12
4 (11 Marks)	Pointers: Declaration and initialization of pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers.	05	01		06
5 (10 Marks)	List of Practical: (computer based) 1. Plot of a graph $y = f(x)$. 2. Roots of a quadratic equation (with imaginary roots also). 3. Sorting of an array and hence finding median. 4. Mean, median and mode of a grouped frequency data. 5. Variance and coefficient of variation of a grouped			08	16
	Total	37	07	08	60

Where,

L: Lectures

T: Tutorials

P: Practical

MODES OF IN-SEMESTER ASSESSMENT:

(40 Marks)

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READING:

1. Kernighan, B. W. and Ritchie, D. (1988): C Programming Language, 2nd edition, PrenticeHall.
2. Balagurusamy, E. (2011): Programming in ANSI C, 6th edition, Tata McGraw Hill.
3. Gottfried, B. S. (1998): Schaum's Outlines: Programming with C, 2nd edition, TataMcGraw Hill

**FOUR YEARS UNDER GRADUATE PROGRAMME IN STATISTICS DETAILED
SYLLABUS OF 4th SEMESTER**

Title of the Course: Industrial Statistics

Code: STAMIN4

Nature of the Course: Minor

Total Credits: 04

Distribution of Marks: 60 (50T + 10P) (End Sem) + 40 (In-Sem)

UNITS	CONTENTS	L	T	P	Total Hours
1 (14 Marks)	Quality: Definition, 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. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical control charts- construction and statistical basis of 3- σ control charts, rational sub-grouping.	12	02	-	14
2 (14 Marks)	Control Charts: Variables- X-bar, R-chart, & s-chart. 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.	09	02	-	11
3 (14 Marks)	Acceptance Sampling Plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.	10	02	-	12
4 (8 Marks)	Introduction to Six-Sigma: Overview of six sigma, lean manufacturing and total quality management (TQM). Organizational structure and six sigma training plans- selection criteria for six-sigma roles and training plans.	06	01	-	7
5 (10 Marks)	List of Practical: (both calculator and computer based) 4. Construction and interpretation of statistical control charts: Variable charts- X-bar, R-chart & s-chart. Attribute charts- np-chart, p-chart, c-chart, & u-chart. 5. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves. 1. Calculation of process capability and comparison of 3-sigma control limits with specification limits.	-	-	08	16
	Total	37	07	08	60

Where, L: Lectures T: Tutorials P: Practical

MODES OF IN-SEMESTER ASSESSMENT:**(40 Marks)**

- Home Assignment
- Presentation: Oral / Poster / Power Point
- Assignments
- Group Discussion
- In Semester examination
- Attendance

SUGGESTED READING:

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6th edition, WileyIndia Pvt. Ltd.
2. Goon A. M., Gupta M. K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th edition. The World Press, Kolkata.
3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montgomery, D. C. and Runger, G. C. (2008): Applied Statistics and Probability for Engineers, 3rd edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd edition, Butterworth Heinemann Publication.
7. S.C. Gupta, V.K. Kapoor (2007): Fundamentals of Applied Statistics, Sultan Chand & Sons.