SRI VENKATESWARA UNIVERSITY:: TIRUPATI

SVU COLLEGE OF SCIENCES

# M.Sc., STATISTICS


Syllabus for M.Sc. Statistics

Choice Based Credit System (CBCS)

**Amended as per NEP 2020**
(w.e.f. the Academic Year 2021-2022)

**VISION:** To en-corporate certain specific objectives and scale to prepare the students to take up challenges in any one or more functional domain

**1. ACADEMICS**

**2. BASIC AND APPLIED RESEARCH**

**3. RESEARCH AND DEVELOPMENT**

**4. SOFTWARE SKILLS**

**5. INDURSTRY**

**6. STATISTICAL ANALYSIS**

**MISSION:** To bring out professional having knowledge of basic laws of nature together with strong fundamentals of in core areas of statistics viz. linear algebra, probability and distributions, statistical inference, multivariate analysis, econometric methods, operations research-i, time series analysis and forecasting methods , operations research-ii. Specializations subjects like….Sampling techniques, stochastic process, linear models and applied regression analysis, computer programming and data analysis, demography and official statistics, bio-statistics, statistical process and quality control, advanced econometric models. Technical subjects like… statistical analysis using excel and spss, python, design and analysis of experiments, industrial statistics and quality control, statistical analysis using R + R practical's

**Program Educational Objectives:** At the end program the student will be able to

- **PEO1:** Apply principals of basic scientific concepts in understanding and predictions of statistical sciences
- **PEO2:** Develop human resources with specializations in theoretical and experimental techniques required for carrier in academic, research and industry
- **PEO3:** Engage in lifelong learning and adopt changing in professional and society needs

**PROGRAM EDUCATIONAL OBJECTIVES:** at the program the student will be able to

- **P01:** Apply the scientific knowledge to solve the statistical data analysis problems
- **PO2:** Identify, formulate and analyze advanced scientific problems reading substantiated conclusions for all kind of disciplines like medical, biological series and so on.
- **PO3:** Creative design solutions for advanced scientific problems `and design system components using statistical analysis that meet the specified need with appropriate attention to health and safety risks.
- **PO4:** Using statistical analysis understanding the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
- **PO5:** Create, select and apply appropriate techniques, resources and modern statistical tools to complex statistical problems with understanding of the limitations.
- **PO6:** analyzing the impact of marketing sales into the society using data science techniques.
- **PO7:** By statistical methods demonstrating the knowledge and understanding the scientific principles and applying the statistical tools to manage projects and in multidisciplinary environments.
- **PO8:** apply ethical principles and norms of scientific practices
- **PO9:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings by statistical approach.
- **PO10:** Understanding the working of various analog communication techniques by using data science methods
- **PO11:** Project management of finance in collaboration with various firms by data science techniques
- **PO12:** Recognize the need and have the preparation and ability to engage independent and life-long learning in the broadest context of scientific and technological change by statistical approach.

**Program Specific Outcomes:** At the end of the program the student will be able to

- **PSO1:** Understand the basic and advanced concepts of probability, distributions.
- **PSO2:** Perform and design experiments in the area of Bio-statistics, advanced Bio-statistics, Time series
- **PSO3:** Apply knowledge on software like Excel, SPSS and R software

**S.V. UNIVERSITY, TIRUPATI**

**DEPARTMENT OF STATISTICS**

**M.Sc., STATISTICS**

**CBCS Pattern (With effect from January, 2021)**

**The course of Study and Scheme of Examinations**

**SEMESTER-I**

| Sl. No. | Course Code | Components of Study | Title of the Course | Contact Hours | No. of Credits | IA Marks | End SEM Exam Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | ST - 101 | Core | Linear Algebra | 6 | 4 | 20 | 80 | 100 |
| 2 | ST - 102 | Core | Probability and Distributions | 6 | 4 | 20 | 80 | 100 |
| 3 | ST - 103 | Generic Elective | a. Sampling Techniques<br>b. Stochastic Process | 6 | 4 | 20 | 80 | 100 |
| 4 | ST - 104 | Core | Practical-I (75 Practical + 25 Record) | 6 | 4 | - | - | 100 |
| 5 | ST - 105 | Compulsory Foundation **(Related to Subject)** | Statistical Computing | 6 | 4 | 20 | 80 | 100 |
| 6 | ST - 106 | Elective Foundation | Practical-II (75 Practical + 25 Record) | 6 | 4 | - | - | 100 |
| | **Total** | | | **36** | **24** | | | **600** |

*** Among the Generic Electives the student shall choose <u>ONE</u>**

**SEMESTER-II**

| Sl. No. | Course Code | Components of Study | Title of the Course | Contact Hours | No. of Credits | IA Marks | End SEM Exam Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | ST - 201 | Core | Statistical Inference | 6 | 4 | 20 | 80 | 100 |
| 2 | ST - 202 | Core | Multivariate Analysis | 6 | 4 | 20 | 80 | 100 |
| 3 | ST - 203 | Core | (a) Linear Models and Applied Regression Analysis<br>(b) Demography and Official Statistics | 6 | 4 | 20 | 80 | 100 |
| 4 | ST - 204 | Core | Practical-III (75 Practical + 15 Viva- voce + 10 Record) | 6 | 4 | - | - | 100 |
| 5 | ST - 205 | Compulsory Foundation **(Related to Subject)** | Design and Analysis of Experiments | 6 | 4 | 20 | 80 | 100 |
| 6 | ST - 206 | Elective Foundation | Practical-IV (75 Practical + 15 Viva- voce + 10 Record) | 6 | 4 | - | - | 100 |
| | **Total** | | | **36** | **24** | | | **600** |

**SEMESTER-III**

| Sl. No. | Course Code | Components of Study | Title of the Course | Contact Hours | No. of Credits | IA Marks | End SEM Exam Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | ST - 301 | Core | Econometric Methods | 6 | 4 | 20 | 80 | 100 |
| 2 | ST - 302 | Core | Operations Research-I | 6 | 4 | 20 | 80 | 100 |
| 3 | ST - 303 | Core | Practical-V (75 Practical + 25 Record) | 6 | 4 | - | - | 100 |
| 4 | ST - 304 | Generic Elective * **(Related to Subject)** | (a) Computer Programming and Data Analysis<br>(b) Bio-Statistics<br>(c) Total Quality Management and Six Sigma | 6 | 4 | 20 | 80 | 100 |
| 5 | ST - 305 | Core | Practical-VI (75 Practical + 25 Record) | 6 | 4 | - | - | 100 |
| 6 | ST - 306 | Open Elective **(For other Department)** | (a) Statistics for Biological and Earth Sciences<br>(b) Statistics for Social and Behavioral Sciences | 6 | 4 | 20 | 80 | 100 |
| | **Total** | | | **36** | **24** | | | **600** |

*** Among the Generic Electives the student shall choose <u>ONE</u>**

**SEMESTER-IV**

| Sl. No. | Course Code | Components of Study | Title of the Course | Contact Hours | No. of Credits | IA Marks | End SEM Exam Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | ST - 401 | Core | Time Series Analysis and Forecasting Methods | 6 | 4 | 20 | 80 | 100 |
| 2 | ST - 402 | Core | Operations Research-II | 6 | 4 | 20 | 80 | 100 |
| 3 | ST - 403 | Core | Practical-VII (75 Practical + 15 Viva-voce + 10 Record) | 6 | 4 | - | - | 100 |
| 4 | ST - 404 | Generic Elective * **(Related to Subject)** | (a) Statistical Process and Quality Control<br>(b) Statistics for Research, industry and Community Development<br>(c) Advanced Econometric Models | 6 | 4 | 20 | 80 | 100 |
| 5 | ST - 405 | Core | **Student Project:** Data Centre / Institutions / Companies and etc., | 6 | 4 | - | - | 100 |
| 6 | ST - 406 | Open Elective **(For other Dept.)** | (a) Business Analytics<br>(b) Survival Analysis | 6 | 4 | 20 | 80 | 100 |
| | **Total** | | | **36** | **24** | | | **600** |

*** Among the Generic Electives the student shall choose <u>ONE</u>**

****** Primary or Secondary data collected from banks, fields or any other relevant areas are analyzed and submitted

**<u>Student Project</u>** : Dissertation - 60 Marks
Viva Voce - 10 Marks
Presentation - 30 Marks
**Total - 100Marks**

**<u>Multidisciplinary Subjects:</u> M.Sc., Mathematics and M.Sc., Computer Science**

# ST 101: LINEAR ALGEBRA

**Unit-I:** Algebra of matrices; Elementary transformations; Rank and Inverse of a matrix; Nullity; Partitioned matrices; Kronecker product; Generalized inverse of matrix; Moore-Penrose generalized inverse; Solutions of simultaneous equations.

**Unit-II:** Finite dimensional Vector Spaces; Vector Spaces and Subspaces; Linear dependence and independence; Basis and dimension of a vector space; Completion theorem; Inner product Spaces; Orthonormal basis and Gram-Schmidt orthogonalization process; Orthogonal projection of a vector.

**Unit-III:** Linear transformations and properties; Orthogonal and unitary transformations; Real quadratic forms; Reduction and classification of quadratic forms; Hermitian forms; Sylvesters law of inertia; Canonical reduction of quadratic form.

**Unit-IV:** Characteristic roots and vectors; Cayley – Hamilton theorem; Minimal polynomial; Similar matrices; Spectral decomposition of a real symmetric matrix; Reduction of a pair of real symmetric matrices; Hermitian matrices.

**References**


1. Graybill, F.A. (1983). Matrices with applications in statistics, 2nd ed. Wadsworth, Belmont (California).
2. Rao, C. R. (1985). Linear statistical inference and its applications, Wiley Eastern Ltd., New Delhi.
3. Searle, S. R. (1982). Matrix Algebra useful for Statistics, John Wiley and Sons. Inc.
4. Bellman, R. (1970), Introduction to Matrix Analysis, 2nd ed. McGraw Hill, New York.
5. Campbell, H.G. (1980), Linear Algebra with Applications, 2nd Edition, Prentice-Hall, Englewood Cliffs (new Jersey), 1980.
6. Biswas, S. (1984), Topics in Algebra of Matrices, Academic Publications.
7. Hadley, G. (1987), Linear Algebra, Narosa Publishing House.
8. Halmos, P.R. (1958), Finite-dimensional Vector Spaces 2nd ed. D.Van Nostrand Company, Inc.
9. Hoffman, K. and Kunze, R, (1971). Linear Algebra, 2nd ed., Prentice Hall
10. Rao, A.R. and Bhimasankaram, P. (1992), Linear Algebra, Tata McGraw Hill Publishing Company Ltd.
11. Rao, C.R. and Mitra, S.K. (1971), Generalized Inverse of Matrices and its Applications, John Wiley and Sons, Inc.
12. Narayan, S. (1970), Theory of Matrices, S. Chand &Company, New Delhi.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-101** | **Linear Algebra** | Theory | Practical | 4 |
| | | 4 | --- | |
| Course Objective | 1. To Prepare Students about algebra of matrices and vector spaces.<br>2. To explain about roots vectors and linear transformations with an Examples.<br>3. To Prepare the students on the concept of the orthonogonality and | | | |

| | |
|---|---|
| | quadratic forms.<br>4. To Make the students to understand the concept of the spectral decomposition of the matrices. |
| Course Out comes | 1. Students understood for estimation of elementary transformations in matrix and their solutions.<br>2. Students learnt about characteristic roots and vectors with numerical examples. They also know theoretical proofs of theorems.<br>3. Discriminate between diagonalizable and non-diagonalizable matrices; orthogonally diagonalizable symmetric matrices and quadratic forms<br>4. Combine methods of matrix algebra to compose the change-of-basis matrix with respect to two bases of a vector space, identify linear transformations of finite dimensional vector spaces and compose their matrices in specific bases |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **2** | **1** | | | | **3** | **2** | **2** | **2** |
| **CO2** | **3** | **2** | **3** | **2** | **1** | | | | **3** | **2** | **2** | **2** |
| **CO3** | **3** | **3** | **3** | **2** | **1** | | | | **3** | **2** | **2** | **2** |
| **CO4** | **3** | **2** | **3** | **2** | **1** | | | | **3** | **2** | **2** | **2** |

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B-248-01-01

# M.Sc. DEGREE EXAMINATIONS, AUGUST - 2021

## FIRST SEMESTER

## BRANCH - STATISTICS

## ST - 101 : Paper - I : LINEAR ALGEBRA

## (COMMON TO M.Sc. APPLIED STATISTICS)

*(Under CBCS w.e.f. 2016-2017)*

*(Common to Supplementary candidates also i.e., who appeared in 2015 and earlier with 70 marks)*

**Time : 3 Hours** **Max. Marks : 80**

### SECTION - A

Answer any **Four** questions. All questions carry **equal** marks. **(4×5=20)**

1. Find inverse of the matrix $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$.

2. Define a non singular linear transformation. State its properties and prove one of them.

3. Let V be a vector space over the filed F. Prove that the intersection of any collection of subspaces of V is a subspace of V.

4. Show that the vectors (3,0,-3), (-1,1,2),(4,2,-2) are linearly independent.

5. Using Cayley - Hamilton theorem obtain $A^2$-6A, when $A = \begin{pmatrix} 3 & 1 \\ 1 & 3 \end{pmatrix}$.

6. Define linear transformation. Is there a linear transformation T from $R^3$ into $R^2$ such that T(1,-1,1) = (1,0) and T (1,1,1) = (0,1).

7. Similar matrices have the same characteristic polynomial.

8. Define Gram matrix and show that a quadratic form in a Gram matrix is either positive definite (or) positive semi definite.

## SECTION - B

Answer all **Four** questions. (4×15=60)

9. a) Define Kronecker product and prove that (15)

i. $A \otimes B$ may not equal $B \otimes A$.

ii. $A \otimes (B + C) = (A \otimes B) + (A \otimes C)$.

iii. $(A \otimes B)^T = A^T \otimes B^T$.

(OR)

b) If $\varphi_{PQ}(A)$ is defined, then prove that $\varphi_{QP}(A^T) = (\varphi_{PQ}(A))^T$. (15)

10. a) Let $S_1, S_2, \ldots, S_k$ be subspaces of a vector space, then the following are equivalent

i. $S_1 + S_2 + \ldots + S_K$ is direct

ii. $(S_1 + S_2 + \ldots + S_i) \cap S_{i+1} = \{0\}$, $1 \le i \le k-1$.

iii. $0 = x_1 + x_2 + \ldots + x_k, x_i \in S_i, 1 \le i \le k \Rightarrow x_i = 0$ for $i = 1, 2, \ldots, k$.

iv. $d(S_1 + S_1 + \ldots + S_k) = d(S_1) + d(S_2) + \ldots + d(S_k)$ (15)

(OR)

b) Find the orthogonal projector into the column space of $A = \begin{pmatrix} 3 & 2 & 1 \\ 1 & 3 & -2 \\ -2 & 1 & -3 \end{pmatrix}$. (15)

11. a) Discuss the procedure to classify a quadratic form. (7)

b) Write the matrices of 3 - ary quadratic form $x_1^2 + x_2^2 - 3x_3^2 + 2x_1x_2 - 6x_2x_3$ (8)

(OR)

c) State and prove Sylvester's law of inertia.

d) Reduce the 3-ary quadratic form $2x_1x_3 + x_2x_3$ to diagonal form using lagrange's method.

12. a) i. State and prove Caylev - Hamilton theorem. (7)

ii. Find the characteristic roots of $\begin{pmatrix} 3 & 5 \\ 1 & 4 \end{pmatrix}$. (8)

(OR)

b) Find a spectral Decomposition of the matrix $A = \begin{pmatrix} 7 & -6 & 6 \\ 2 & 0 & 4 \\ 1 & -2 & 6 \end{pmatrix}$. (15)

# ST 102: PROBABILITY AND DISTRIBUTIONS

**Unit-I:** Classes of sets, fields, σ -fields, minimal σ -field, Borel σ – field in $R^K$, sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue-Stieltjes measures, Measurable functions, Random variables, sequence of random variables, almost sure convergence, convergence in probability (and in measure). Monotone convergence theorem, Fatou's lemma, Dominated convergence theorem.

**Unit-II:** Expectation of a random variable, inequalities on expectations, Markov, Holder, Jensen and Liapiunov inequalities. Borel- Cantelli - Lemma, Independence, Weak law and strong law of large numbers for iid sequences, Chebyshev's theorem, khinchine's theorem, Kolmogorov theorems (statements only), convergence in distribution.

**Unit-III:** Laplace and Weibull distributions. Functions of random variables and their distributions, sampling distributions: central Chi Square, t and F distributions and its properties, applications, relation between t and F, F and $\chi^2$; Fisher's Z-distribution, fisher's Z-transformation. Non-central chi-square, t and F distributions and their properties.

**Unit-IV:** Multiple and partial correlation coefficients, multiple linear regression, inter relationship among partial and multiple correlation and regression coefficients. Null distributions of simple, partial and multiple correlation coefficients. Order statistics and their

distributions, joint and marginal distributions of order statistics, distribution of range. Extreme values and their asymptotic distributions.

**References**


1. Ash, Robert. (1972). Real Analysis and Probability. Academic Press.
2. Billingsley, P. (P. (1986) Probability and Measure. Wiley.
3. Kingman, J F C and Taylor, S. J. (1966). Introduction to Measure and Probability. Cambridge University Press.
4. Loeve, M (1963), Probability theory
5. Bhatt B.R (1998), Modern Probability theory, Wiley Eastern
6. Rohatgi V.K. (1984): An Introduction to probability theory and mathematical statistics.
7. Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.
8. Pitman J. (1993): Probability, Narosa Publishing House.
9. Johnson, N.L and Kotz, S.M. (1972): Distributions in Statistics, Vol. I , II & III. Houghton and Miffin.
10. David H.A (1981): Order Statistics, II Edition, and John Wiley.
11. Feller W (1966): Introduction to probability theory and its applications, Vol. III, second edition. Wiley Eastern.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-102** | **Probability and Distributions** | Theory | Practical | 4 |
| | | 4 | --- | |
| Course Objective | 1. To Explain about classes of sets and Probability measures<br>2. To discuss on random variables and convergence in probability and the important theorems with proofs.<br>3. To discuss about inequalities on expectations with their derivations and laws of numbers.<br>4. To explain about different discrete and continuous distributions and their properties.<br>5. To learn about derivations and properties of various sampling distributions.<br>6. To explain order Statistics and their properties | | | |
| Course Out comes | 1. Students must have knowledge about random variables, expectations, sets and their properties and inequalities where ever necessary.<br>2. Students also know the weak law, strong law and central limit theorem and their importance<br>3. Students know about different continuous and discrete distributions and their properties.<br>4. They have awareness about central and non-central sampling distributions and order Statistics. Idea about simple, partial and multiple correlation coefficients. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **1** | **1** | | | | **1** | | **2** | **3** |
| **CO2** | **3** | **2** | **1** | **1** | **1** | | | | **1** | | **2** | **3** |
| **CO3** | **3** | **2** | **1** | **1** | **1** | | | | **1** | | **2** | **3** |
| **CO4** | **3** | **2** | **1** | **1** | **1** | | | | **1** | | **2** | **3** |

## MODEL QUESTION PAPER

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

FIRST SEMESTER

**Branch : STATISTICS**

**ST-102 : Paper II – PROBABILITY AND DISTRIBUTIONS**

**(Common to M.Sc. Applied Statistics)**

(Under NEP 2021 )

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions

All questions carry equal marks

(Marks : 4 x 5 = 20)

1. Define Field and minimal sigma field.
2. State and prove nominated convergence theorem.
3. State and prove markov inequality.
4. Write down the statement of Borel Cantelli Chebyshev's theorems.
5. Write down the distribution function of weibull distribution and derive its M.G.F.
6. Derive C.F. of chi-square distribution.
7. Define partial and multiple correlations and explain their inter relationship.
8. Explain order statistics and its mean and variance with example.

SECTION – B

Answer any FOUR questions. Each question carries 15 marls.

(Marks : 4 x 15 = 60)

9. (a) State and prove monotone convergence theorem.

(or)

(b) Explain about Lebesgue-Stieltjes measure.

10. (a) State and prove Khinchine's weak law of large numbers.

(or)

(b) State and prove holder inequality.

11. (a) Derive the MGF of Laplace distribution of second kind and its moments.

(or)

(b) Derive non-central F distribution also find its mean and variance.

12. (a) Write a note on multiple linear regression. Explain its null distribution.

(or)

(b) Derive distribution of order statistics $Y(\alpha)$ of the sample. Also derive the joint

- distribution of $Y(\alpha)$ $Y(\beta)$.

# ST 103 (a) : SAMPLING TECHNIQUES

**Unit-I**: Review of basic concepts of sampling theory such as sampling design, sampling scheme, sampling strategy etc., Sampling with varying probability with and without replacement, PPS WR/WOR methods – Lahiri's sample scheme, Hansen – Hurwitz, Des Raj estimators for a general sample size and Murthy estimator for a sample of size 2, Symmentrized Des Raj estimator.

**Unit-II:** Hurwitz – Thompson estimator (HTE) of a finite population total / mean, expression for V(HTE) and its unbiased estimator. IPPS scheme of a sampling due to Midzuno – Sen and JNK Rao (sample size 2 only). Rao – Hartley-Cochran sampling scheme for a sample of size n with random grouping.

**Unit-III:** Ratio and Regression methods of estimation, Two stage sampling, Multi stage sampling, Cluster sampling. Resampling methods and its applications.

**Unit-IV:** Double sampling for difference, ratio, regression and PPS estimators; Large scale sample surveys, Errors in surveys, A mathematical model for errors of measurement, Sampling and Non-sampling errors, Sources and types of non-sampling errors, Remedies for non-sampling errors.

## References


1. Chaudhuri. A and Mukerji. R (1988): Randomized Response Theory and Techniques, New Yory, Marcel Dekker Inc.
2. Cochran W.G (1988): Sampling Techniques III Edition (1977) Wiley.
3. Des Raj and Chandak (1988): Sampling Theory. Narosa.
4. Murthy M.N (1977): Sampling Theory and Methods. Statistical Publishing Society.
5. Sukhatme et al (1984): Sampling Theory of Surveys with Applications. Iowa State University Press & IARS
6. Sing D and Chudary F.S (1986): Theory and Analysis of Sample Survey Designs. New Age International Publishers.
7. Hedayat A.S and Sinha B.K. (1991): Design and Inference in Finite Population Sampling. Wiley.
8. Mukhopadhyay P(1996): Inferential problems in Survey Sampling. New Age International.
9. Wolter K.M (1985): Introduction to Variance Estimator. Springer. Verlag.
10. Hansen M.M and Hurwitz W.M and Mandow W.G (1954): Sample Survey Methods and Theory, Vol. I and Methods and Applications Vol. II, John Wiley and Sons.
11. Philli. I. Good (2013):Introduction to statistics through resampling methods and R, 2nd edition.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-103 (a)** | **Sampling Techniques** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. Discuss about basic concepts of sampling techniques PPS WR/WOR models.<br>2. To study about Hurwitz Thompson estimator, PPS scheme.<br>3. To learn about Ratio and Regression methods and their properties.<br>4. To explain Double sampling for difference estimators using ratio regression and PPS's, Non sampling error and their remedies. | | | |
| Course Out comes | 1. Students learnt different sampling techniques of with replacement/ without replacement and Different sampling models.<br>2. Students studied non-Sampling errors and different remedies.<br>3. Implement Cluster sampling, Ratio and Regression estimation in real life problems<br>4. Apply unequal probability sampling designs viz. PPSWR, PPSWOR including Lahiri's method and Murthy's estimator for survey. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **3** | **3** | **1** | | | **2** | | **2** | **2** |
| **CO2** | **3** | **2** | **1** | **3** | **3** | **1** | | | **2** | | **2** | **2** |
| **CO3** | **3** | **2** | **1** | **3** | **3** | **1** | | | **2** | | **2** | **2** |
| **CO4** | **3** | **2** | **1** | **3** | **3** | **1** | | | **2** | | **2** | **2** |

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B-248-02-04

M.Sc. DEGREE EXAMINATIONS, OCTOBER -2021

SECOND SEMESTER

Branch : STATISTICS/APPLIED STATISTICS

ST-103 : Paper-IIIa : Sampling Techniques

*(Under CBCS w.e.f. 2016-2017)*

*(Common to Supplementary candidates also who appeared in 2015 and 2016 only with 70 marks)*

Time : 3 Hours

Max. Marks : 80

## SECTION - A

Answer any **Four** questions. Each question carry equal marks. (4×5=20)

1. Explain the basic concepts of sampling theory.
2. Explain the procedure for PPS sampling.
3. Define Hurwitz-Thompson estimator and its variance.
4. Explain the un-biased estimator for HTE (Hurwitz- Thomson estimator) and its applications with suitable example.
5. Explain about Re-Sampling methods and its applications.
6. Explain about cluster sampling with an examples.
7. Explain briefly about sampling and Non sampling errors.
8. Explain about sources and types of Non-sampling Error.

## SECTION - B

Answer **All** questions. Each question carries 15 marks. (4×15=60)

9. a) Explain about Hansen-Hurwitz and Des Raj estimators for a general sample size.

(OR)

b) Explain about PPS with replacement and without replacement and also explain about Lahiri's sample scheme.

10. a) Explain about a IPPS scheme of a sampling due to Midzuno-sen and JNK Rao.

(OR)

b) Define about Rao-Hartley-cochran sampling scheme for a sample of size n with random grouping.

11. a) Discuss the relative efficiences of ratio and regression estimator.

(OR)

b) Explain about Multi-Stage sampling with suitable example and also explain its applications.

12. a) Describe about double sampling and what are its advantages with its applications

(OR)

b) What are the Remedies of Non-sampling errors and also construct mathematical model for errors of measurement.

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# ST 103 (b) : STOCHASTIC PROCESSES

**Unit-I**: Introduction to stochastic processes (sp's): classification of sp's according to state apace and time domain. Countable state Markov chains (MC's), Chapman – Kolmogorov equations, calculation of n – step transition probability and its limit. Stationary distribution, classification of states,, transient MC, random walk and gambler's ruin problem.

**Unit-II:** Discrete state space continuous time MC: Kolmogorov – Feller differential equations, Poisson process, birth and death process; Applications to queues and storage problems. Wiener process as a limit of random walk, first – passage time and other problems.

**Unit-III**: Renewal theory: Elementary renewal theorem and applications. Statement and uses of key renewal theorem, study of residual life time process: weakly stationary and strongly stationary process; Moving averages and auto regressive process.

**Unit-IV**: Branching process: Galton – Watson branching process, probability of ultimate extinction, distribution of population size. Martingale in discrete time, inequality, convergence and smoothing properties. Statistical inference in MC and Markov process.

## References


1. Adke, S.R and Manjunath, S.M (1984): An Introduction to Finite Markov Processes, Wiley Eastern.
2. Bhat, B.R (2000): stochastic Models: Analysis and Applications, New Age International, India.
3. Cinlar, E (1975): Introduction to Stochastic Processes, Prentice Hall.
4. Feller, W (1968): Introduction to Probability and its Applications, Vol. 1, Wiley Eastern.
5. Harris, T.E (1963): The Theory of Branching Processes, Springer – Verlag.
6. Hoel, P.G., Port, S.C and Stone, J.C (1972): Introduction to Stochastic Processes, Houghton Miffin & Co.
7. Jagers, P (1974): Branching Process with Biological Applications, Wiley.
8. Karlin, S and Taylor, H.M (1975): A First Course in Stochastic Processes, Vol. 1, and Academic Press.
9. Medhi, J (1982): Stochastic Processes, Wiley Eastern.
10. Parzen, E (1962): Stochastic Processes, Holden – Day.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-103 (b)** | **Stochastic Process** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To explain stochastic process and their classification according to space and domain.<br>2. To discuss about Birth and death process, Renewal theory and its applications, stochastic process and their importance, Markov chains, Poisson process, Renewal theory, Branching process etc.<br>3. To explain the concept of the Moving Averages and its applications.<br>4. | | | |
| Course Out comes | 1. Students understood stochastic processes, Markov chains, Poisson process, Renewal theory, Branching process, etc.<br>2. Explain Random walk, Gambler ruins problem and apply Poisson process in real life situations.<br>3. Understand the consequences of the Intermediate value theorem for continuous function.<br>4. Know the chain rule and use it to find derivatives of composite functions and obtain expression for higher order derivatives of a function using the rule of differentiation. Solve integrals and evaluation of multiple integrals with numerical problems. | | | |

# Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **1** | **1** | | | | **1** | **1** | **2** | **1** |
| **CO2** | **3** | **2** | **1** | **1** | **1** | | | | **1** | **1** | **2** | **1** |
| **CO3** | **3** | **2** | **1** | **1** | **1** | | | | **1** | **1** | **2** | **1** |
| **CO4** | **3** | **2** | **1** | **1** | **1** | | | | **1** | **1** | **2** | **1** |

M.Sc. DEGREE EXAMINATION, MAY 2014

(041220402)

SECOND SEMESTER

**Branch — Statistics with Computer Applications**

*Time : 3 Hours* **ST-103 Paper- III (b) STOCHASTIC PROCESSES** *Max. Marks : 70*



**PART – A**

Answer any FOUR questions, each question carries 5 marks.

(Marks : 4 × 5 marks = 20 marks)

1. Define Markov Chain and represent M.C. as a graph.
2. Explain random walk.
3. Define Poisson process and explain the postulates.
4. Show that the difference between two Poisson processes is not a Poisson process.
5. Define renewal process with an example.
6. Show that :

   (a) $p_n(t) = P[N(t) = n] = F_n(t) - F_{n+1}(t)$ and

   (b) $M(t) = \sum_{n=1}^{\infty} F_n(t)$.
7. Explain branching process.
8. Write a note on statistical inference in Markov process.

**PART – B**

Answer ONE question from each Unit.

(Marks : 4 × 12.5 marks = 50 marks)

9. Define state space, parametric space and hence explain stochastic process with classification. Give examples in each case.

**Or**

10. Show that if state K is persistent null, then for every $\lim_{n \to \infty} p_{jk}^{(n)} = 0$ and if stat K is aperiodic persistent non-null then $\lim_{n \to \infty} p_{jk}^{(n)} = F_{jk} / \mu_{kk}$.

[P.T.O]

13. Explain the problem of classification and discrimination. Explain the proce... classification into two multivariate normal populations.

**Or**

14. Define Wishart distribution and obtain its distribution function.

15. Explain in detail about multiple linear regression model. Also explain about least squa... estimation procedure for obtaining the parameters in multiple linear regression model. (12.5)

**Or**

16. Define principal components and discuss their use in statistical analysis. Obtain the ... estimates of principal components. (12.5)

# ST 104 (A) : STATISTICAL ANALYSIS USING EXCEL AND SPSS

**Unit-I:** Review of Excel, sorting, filtering and construction of charts. Curve fitting and interpretation of the output. Statistical functions in Excel - Calculating theoretical probability using Binomial, Poisson and Normal distributions. Matrix operations- Transpose, Product and Inverse operations using Excel. Pivot tables and look up functions.

**Unit-II:** Data Analysis Pak in Excel, descriptive statistics, tests of hypothesis, ANOVA, Correlation and Regression, Random Number Generation from different distributions, Binomial, Poisson, Uniform, Normal and from discrete distributions with given mean and variance. Forecasting Using Excel – Moving Averages and Exponential Smoothing, Use of functions, Linest, Logest, Forecast , Growth, Trend for trend analysis. The use of solver for optimization – Application to LPP.

**Unit-III:** Introduction to SPSS, Different Menu's in SPSS, creating a data file, opening excel files,variables and labels,selecting casesby filtering,recoding of data, merging of files, Sorting of Cases and Variable, SPSS Output and its transfer to excel and word. Analysis categorical data- Scales of Measurements, Data reliability-test rest method, Cronbach's alpha.

**Unit-IV:** Using SPSS Analysis tools, descriptive statistics, cross tabs (with stress on procedures and syntax). Post-hoc analysis for multiple comparisons using Tukey's test, Duncan's Multiple Range Test, Dunnet's test and Scheffe's test with interpretation. Selection of variables in Multiple Linear Regression – stepwise procedures and analysis of residuals. Procedure for Binary Logistic regression, Factor analysis, Linear Discriminant analysis and Cluster analysis.

<table>
<tr><td>Subject Code</td><td>Subject Name</td><td colspan="2">Credits Allotted</td><td>Total</td></tr>
<tr><td rowspan="2">ST-104(A)</td><td rowspan="2">Statistical Analysis Using Excel and SPSS</td><td>Theory</td><td>Practical</td><td rowspan="2">4</td></tr>
<tr><td>4</td><td>----</td></tr>
<tr><td>Course Objective</td><td colspan="4">1. To Learn the students about the Statistical functions in Excel.<br>2. To teach the students the concept of Data Analysis Pak in Excel.<br>3. To give the introduction of SPSS and its concepts to the students.<br>4. To teach the students concepts like multiple comparision tests, Regression analysis etc.</td></tr>
<tr><td>Course Out comes</td><td colspan="4">1. Students can learn how to enter the data MS-Excel.<br>2. Students can analyze the data in Excel and SPSS.</td></tr>
</table>

| | |
|---|---|
| | 3. Students can learn how to transfer the data in one data Analysis application to Another.<br>4. Students can predict the future data using SPSS Procedures. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **2** | **3** | **1** | | | **1** | **2** | **3** | **3** |
| **CO2** | **3** | **3** | **2** | **2** | **3** | **1** | | | **1** | **2** | **3** | **3** |
| **CO3** | **3** | **3** | **2** | **2** | **3** | **1** | | | **1** | **2** | **3** | **3** |
| **CO4** | **3** | **3** | **2** | **2** | **3** | **1** | | | **1** | **2** | **3** | **3** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

FIRST SEMESTER

**Branch : STATISTICS / APPLIED STATISTICS**

APST-104(A): STATISTICAL ANAYSIS USING EXCEL AND SPSS

(Under NEP 2021 ) .

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions All questions carry equal marks (Marks : 4 x 5 = 20)

1. Explain sorting in Excel using an example.
2. List out steps for Binomial distribution in Excel.
3. Describe steps for fitting linest.
4. Explain moving averages of order(4) using Excel.
5. Describe with illustration.
6. Write about cronbach's alpha.
7. Explain Schefle's test in SPSS.
8. Explain T- test using SPSS.

SECTION – B

Answer any FOUR questions. Each question carries 15 marks. (Marks : 4 x 15 = 60)

9. (a) Explain Matrix operations with illustrations using Excel
   (or)
   (b) Describe curve fitting using Excel.
10. (a) Explain ANOVA using Excel.
   (or)
   (b) Describe Trend analysis using Excel.
11. (a) Write about reliability test rest method
   (or)
   (b) Explain descriptive statistics using Excel functions.
12. (a) Describe Two way ANOVA with replications using SPSS.
   (or)
   (b) Explain cluster analysis and their interpretation using SPSS.

# ST 104 (B) : PYTHON

**UNIT – I: Introduction to Python Programming Language:**

Introduction to Python Language, Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators,

Numeric Data Types, Conversions, Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections, In Functions.

**UNIT –II : Object and Classes :**

Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes.

**UNIT –III : Functions and Modules :**
Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules, Standard Modules – sys,□Standard Modules – math, Standard Modules – time,The dir Function**.**

**UNIT –IV : I/O and Error Handling In Python :**

Introduction, Data Streams,□Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data From a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions.

**Books for Study:**

1. Dive into Python, Mike
2. Learning Python, 4th Edition by Mark Lutz
3. Programming Python, 4th Edition by Mark Lutz

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-103 (b)** | **Python** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. Able to understand the concept of Python Programming**.**<br>2. Expertise in Object and Classes.<br>3. To be able to explore Functions and Modules learning.<br>4. Able to understand the concept of I/O and Error Handling in Python. | | | |
| Course Out comes | **1.** Students have done Python Programming and their Object and Classes.<br>**2.** Students have understood I/O and Error Handling in Python.<br>**3.** Students can understand the looping problems.<br>**4.** Students can do basic EDA. | | | |

## Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | **2** | | | | **1** | **2** | **3** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **2** | | | | **1** | **2** | **3** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **2** | | | | **1** | **2** | **3** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **2** | | | | **1** | **2** | **3** | **2** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

FIRST SEMESTER

**Branch : STATISTICS / APPLIED STATISTICS**

**ST-104(B) :: PYTHON**

(Under NEP 2021 ) .

Time : 3 Hours Max. Marks:80

**SECTION – A**

Answer any four questions. Each question carries 5 marks. (Marks: 4 x 5 = 20)

1. Write down the Strengths and Weaknesses of Python Language.
2. Explain Control Flow and Syntax.
3. What are the Classes in Python ?
4. Write a note on Inheritance.
5. Explain the Optional Parameters in Python.
6. Write a short note on the dir Function in Python.
7. Explain about Data Streams.
8. What are Run Time Errors ?

**SECTION -B**

Answer ALL questions. Each question carries 15 marks. (Marks: 4 x 15 =60)

9. (a) Explain Relational, Logical, True or False and Bit Wise Operators in "Python".

(Or)

(b) Write about Dynamic Types, Naming Conventions, String Values and String Operations.

10. (a) What are the Principles of Object Orientation ? Discuss.

(Or)

(b) Write about File Organization in Python.

(c) Discuss on Custom Exception Classes.

11. (a) Discuss on Variable Number of Arguments.

(b) Write about Passing Collections to a Function.

(Or)

(c) What are the Modules in Python ? Discuss on Standard Modules – sys, – math, and – time.

12. (a) Write about Access Modes in Python.

(b) Discuss the Additional File Methods in Python.

(Or)

(c ) What are the Handling IO Exceptions ? Explain.

(d) Explain about Exception Model in Python.

# ST 105 : PRACTICAL-I

At least 24 practicals covering papers relating to the subjects Linear Algebra, Sampling Techniques in this semester must be carried out. (75 marks for practical examination + 25 marks for record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-105** | **PRACTICALS** | Theory | Practical | 4 |
| | | ---- | 4 | |
| Course Objective | 1. To write different problems manually solving through calculators.<br>2. To write problems and solving them on computers using Statistical software like Excel and other relevant software etc.,<br>3. To make the students to apply the statistical techniques in the Real life.<br>4. To know the statistical analysis using R software. | | | |
| Course Out comes | 1. Numerical problems related to, Linear Algebra and Sampling Techniques are solved by executing programs of computers.<br>2. Linear algebra concepts when working with data preparation, such as one hot encoding and dimensionality reduction.<br>3. Applying linear algebra problems in real life situations.<br>4. Perform sampling methods analysis using R-software. | | | |

## Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO2** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO3** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO4** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |

## ST 106 : PRACTICAL-II

At least 24 practical's covering papers relating to the subjects Probability, Distribution, Ms Excel and SPSS in this semester must be carried out. (75 marks for practical examination + 25 marks for record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-106** | **PRACTICALS** | Theory | Practical | 4 |
| | | ---- | 4 | |
| Course Objective | 1. To write different problems manually solving through calculators.<br>2. To write problems and solving them on computers using Statistical software like Excel and other relevant softwares like easy fit etc.,<br>3. To teach the students how to use the real life data in computers for analysis.<br>4. To bring the awareness of statistical analysis and descriptive analysis using SPSS. | | | |
| Course Out comes | 1. Numerical problems related to Probability and Distribution Theory, are solved by executing programs on computers.<br>2. Calculate probabilities relevant to multivariate distributions, including marginal and conditional probabilities and the covariance of two random variables<br>3. Perform inferential statistical analysis through SPSS.<br>4. Compute descriptive statistics using SPSS. | | | |

# Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO2** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO3** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |
| **CO4** | **3** | **3** | **3** | **2** | **2** | **2** | | | **2** | **3** | **1** | **2** |

# SEMESTER – II

## ST 201: STATISTICAL INFERENCE

**Unit-I:** Point estimation – Un biased ness, Consistency, Efficiency and Sufficiency; Fisher-Neyman factorization theorem, complete sufficient statistics, minimum variance unbiased estimator (MVUE), Cramer - Rao inequality, Battacharayas inequality, Rao – Blackwell theorem. Exponential family, Maximum Likelihood estimation method, method of moments, method of minimum chi-squares and interval estimation.

**Unit-II:** Tests of hypothesis: Basic concepts, Most Powerful (MP) test, Neyman – Pearson Lemma, Consistency and Unbiased tests, Uniformly Most Powerful (UMP) test, UMP Unbiased tests, similar critical regions, Lehmann – Scheffe theorem, Likelihood Ratio Tests, Asymptotic Distribution of LR test, Bartlett's test for homogeneity of variances and Wald Test.

**Unit-III:** Non – Parametric tests of significance; Sign Test, Wilcoxon-Mann-Whitney U-test, Run test, Kolmogorov - Simrnov one and two sample tests, Median test, Kendall's $\tau$ test. Concept of asymptotic relative efficiency, CAN, BAN, CAUN and BEST CAUN estimators, MLE in Pitman family and Double Exponential distribution, MLE in Censored Truncated distribution.

**Unit-IV:** Statistical decision theory – decision problems and two person games, problems of inference viewed as decision problems, non-randomized and randomized decision rules, Loss and Risk functions, admissibility, complete and essentially complete class, complete class theorem. Bayes principle, determination of Bayes rule Minimax principle, determination of minimax rule, minimax theorem. Minimax estimates of parameters of Binomial, Poisson and Normal distributions.

**References:**


1. Rohtagi, V.K (1988): An Introduction to Probability and Mathematical Statistics, Wiley Eastern
2. Rao C.R (1973), Linear Statistical Inference and its applications, (Revised Edition), Wiley Eastern
3. Lehmann, E.L (1986), Theory of point estimation, (Student Edition)
4. Lehmann, E.L (1986), Testing Statistical Hypothesis (Student Edition)
5. Gibbons, J.D (1985), Non-parametric statistical inference, 2nd Edition, Mercel Dacker Inc
6. Siegal Sidney (1987), Non-parametric Statistics for behavioral sciences, 3rd Edition, Springer Verlog
7. Kendal, M.G and Stuart, A (1968), The advanced theory of statistics, Vol-II, Chales Griffin and Co., London
8. Ferguson, T.S (1967), Mathematical Statistics – a decision theoretic approach, Academic Press
9. Goon, A.M, Gupta, M and Das Gupta, B (1980), An outline of statistical theory, Vol-II, World Press, Calcutta.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 201** | **STATISTICAL INFERENCE** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To study the Estimation methods of point and their different measures and theorems, inequality.<br>2. To discuss about Testing of hypothesis that contains NP Lemma, UHP test, Bartlett's, Wald test, LR test and some theorems relates to hypothesis testing.<br>3. To discuss different non-parametric tests with examples. Asymptotic relative efficiency and truncated distributions.<br>4. To study the Game theory and their problems, minimax rule, minimax theorem and minimum estimates of parameters using different distributions. | | | |
| Course Out comes | 1. Students know about point estimation, non-parametric models, Game theory, theorems and Proofs where ever necessary.<br>2. They can understand the concept of random sample from a distribution, sampling distribution of statistic, standard error of important estimates such as mean and proportions.<br>3. Students may gain the knowledge of testing of hypotheses (both large sample test and small sample test).<br>4. They can also calculate the problems related to point estimation and interval estimation. | | | |

# Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **2** | **1** | | | | **1** | | **1** | **2** |
| **CO2** | **3** | **2** | **2** | **2** | **1** | | | | **1** | | **1** | **2** |
| **CO3** | **3** | **2** | **2** | **2** | **1** | | | | **1** | | **1** | **2** |
| **CO4** | **3** | **2** | **2** | **2** | **1** | | | | **1** | | **1** | **2** |

[Total No. of Pages : 2

B-248-02-01

M.Sc. DEGREE EXAMINATIONS, OCTOBER -2021

SECOND SEMESTER

Branch : STATISTICS/APPLIED STATISTICS

ST-201 Paper : I - STATISTICAL INFERENCE

*(Under CBCS w.e.f. 2016-2017)*

Time : 3 Hours

Max. Marks : 80

## SECTION - A

Answer any **FOUR** questions. Each question carry **Equal** marks. (4×5=20)

1. Define point estimation with an example.
2. Explain moment method of estimation.
3. Define Consistency.
4. Explain uniformly most powerful test.
5. Explain the concept of median test.
6. Define CAN and CAVN estimators.
7. Explain the complete class theorem.
8. Explain the loss and risk functions.

## SECTION - B

Answer **ALL** questions. All question carries **Equal** marks. (4×15=60)

9. a) State and prove Fisher-Neyman Factorization theorem.

(OR)

b) State and prove cramer-Rao inequality with regularity conditions.

10. a) State and prove Neyman-Pearson Lemma.

(OR)

b) Write about wald test with their importance.

11. a) Explain in detail about Kolmogorov–Smirnov one and two sample tests.

(OR)

b) Explain in detail about :

i. Sign Test

ii. Wilcoxon-Mann Whitney U-test

12. a) Obtain the minimax estimates of the parameters of Poisson and normal distributions.

(OR)

b) Explain minimax principle, determination of minimax rule and minimax theorem.

---

## ST 202: MULTIVARIATE ANALYSIS

**Unit-I:** Multivariate normal distribution, marginal and conditional distributions, characteristics functions, Maximum likelihood estimators of parameters, distribution of sample mean vector and dispersion matrix, distribution of quadratic form in the exponent of the multivariate normal density.

**Unit-II:** Hotelling's $T^2$ and its applications – $T^2$ distribution, application of $T^2$ to single sample, two sample and multiple sample problems, optimum properties of $T^2$ test. Mahalobis $D^2$ statistic and its distribution, Multivariate Analysis of Variance (MANOVA) of one and two-way classified data.

**Unit-III:** Classification and discrimination: procedures for classification into two multivariate normal populations, Fisher's Discriminant function, classification into more than two multivariate normal populations, Wishart distribution and its properties, concept of sample generalized variance and its distribution.

**Unit-IV:** Principal Component Analysis – properties, method of extraction of principal components; Canonical variables and canonical correlations; Factor Analysis – mathematical model, estimation of factor loading, concept of factor rotation; Cluster Analysis – similarities and dissimilarities, Hierarchical clustering: single and complete linkage method.

**References**


1. Anderson, T.W (1983), An introduction to Multivariate Statistical Analysis, Wiley, 2nd Edition.
2. Rao, C.R (1973), Linear Statistical Inference and its applications, 2nd edition, Wiley
3. Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland
4. Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
5. Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
6. Sharma, S (1996), Applied Multivariate Techniques, Wiley
7. Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
8. K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 202** | **Multivariate analysis** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To study about Multivariate normal distributions and their properties, it's importance.<br>2. To discuss Hotelling's $T^2$, Mahalanobis $D^2$ statistic and its applications and properties.<br>3. To explain MANOVA with one and two way classified data.<br>4. To discuss about Principal Component Analysis, Factor Analysis and Cluster Analysis with appropriate methods. | | | |
| Course Out comes | 1. Students learnt about importance of multivariate variables and their distributions<br>2. $T^2$, $D^2$, MANOVA models are understood and know it's importance.<br>3. Implement dimension reduction techniques using software on real life problems.<br>4. Classification analysis methods explained according to their classification algorithm. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **1** | **3** | **1** | | | **2** | | **1** | **1** |
| **CO2** | **3** | **3** | **2** | **1** | **3** | **1** | | | **2** | | **1** | **1** |
| **CO3** | **3** | **3** | **2** | **1** | **3** | **1** | | | **2** | | **1** | **1** |
| **CO4** | **3** | **3** | **2** | **1** | **3** | **1** | | | **2** | | **1** | **1** |

[Total No. of Pages : 2

B-248-02-02

M.Sc. DEGREE EXAMINATIONS, OCTOBER - 2021
SECOND SEMESTER
Branch - STATISTICS /APPLIED STATISTICS
ST - 202 Paper - II : MULTIVARIATE ANALYSIS
*(Under CBCS w.e.f. 2016-17)*
*(Common to Supplementary candidates also who appeared in 2015 and 2016 only with 70 marks)*

Time : 3 Hours | Max. Marks : 80

## SECTION - A

Answer any **FOUR** questions. Each questions carry **5** marks. (4×5=20)

1. Suppose a multivariate normal vector is partitioned into two sub vectors and if they are uncorrelated, then show that the two sub vectors are independently distributed.
2. Obtain characteristic function of multivariate normal (MVN) distribution.
3. State and prove the invariance property of Hotelling's $T^2$ statistic.
4. Define Mahalnobi's $D^2$ statistic and obtain it's distribution.
5. Define Wishart distribution and establish it's additive property.
6. Distinguish between classification and discrimination with suitable examples.
7. Define the first k principle components and show that the sum of the variances of all principal components is equal to the sum of the variances of all original variables.
8. Distinguish between single linkage (SLINK) and complete linkage (CLINK) methods.

## SECTION - B

Answer **ALL** questions. All questions carries **15** marks. (4×15=60)

9. a) Show that the sample mean vector and sample dispersion matrix of the multivariate normal distribution are independently distributed.

(OR)

b) Prove that the marginal distribution obtained from the multivariate normal distribution is normal.

10. a) Discuss a test procedure for testing the equality of mean vectors of two multivariate normal populations having equal dispersion matrix.

(OR)

b) Describe two way MANOVA.

11. a) Derive the distribution of the sample generalized variance in case of multivariate normal distribution.

(OR)

b) Explain Fisher's method of classification into one of the several known multivariate populations.

12. a) Briefly explain factor analysis and discuss the principal component estimation method of factor loadings.

(OR)

b) What are canonical variates and canonical correlations? How do you compute them?

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## ST 203 (A) : LINEAR MODELS AND APPLIED REGRESSION ANALYSIS

**Unit-I:** Two and Three variable Linear Regression models; General linear model: Assumptions; OLS estimation; BLUE; Tests of significance of individual regression coefficients; Testing the equality between two regressions coefficients; Test of significance of complete regression.

**Unit-II:** Criteria for model selection; Goodness of fit measures; $R^2$ and adjusted $R^2$ Criteria; $C_p$ criterion; testing the general linear hypothesis; Chow test for Equality between sets of regression coefficients in two linear models; test for structural change; restricted least squares estimation; Generalized Mean Squared error criterion.

**Unit-III:** Non-normal disturbances and their consequences; test for normality; Jarque-Bera test; Shapiro-Wilk test, Minimum Absolute Deviation (MAD) estimation; Box-Cox transformations.
Statistical analysis of residuals, OLS residuals, BLUS residual, Studentised residual, Predicted residual, tests against heteroscadasticity.

**Unit-IV:** Non-Linear regression; Non linear least squares estimation; Maximum Likehoodestimation; Idea of computational methods; Gradient methods, Steepest descent method and Newton-raphson method; testing general Nonlinear hypothesis; Wald test, Lagrange multiplier test and likelihood ratio Test. Robust , probit, binomial logistic ,multiple logistic regression.

**References**


1. Johnston, J (1984): Econometric Methods, III rd edition. MC Graw Hill.
2. Gujarathi, D (1979): Basic Econometrics, MC Graw Hill.
3. Judge, C.G., Griffiths, R.C.Hill, W.E ., Lutkephol, H and Lee, T.C (1985): The Theory and Practice of Econometrics, John Wiley and Sons.
4. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 203(a)** | **Linear models and Applied Regression Analysis** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To discuss about linear regression models and their assumptions.<br>2. To study about different criteria for model selection and their Goodness of fit measures.<br>3. To explain Non normal disturbances and their consequences and statistical analysis of residuals.<br>4. To discuss about Non-linear regression estimation methods. | | | |
| Course Out comes | 1. Students learnt about different linear and non-linear regression models and their appropriate computational procedures.<br>2. They know $R^2$, adjusted $R^2$ and $C_p$ criteria for model selection.<br>3. They will get the knowledge of building and fitting linear regression models with software. | | | |

| | |
|---|---|
| | 4. They also learn about the theory underlying point estimation,hypothesis and confidence intervals for linear regression models. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **2** | **2** | **1** | | | **2** | | **1** | **2** |
| **CO2** | **3** | **3** | **3** | **2** | **2** | **1** | | | **2** | | **1** | **2** |
| **CO3** | **3** | **3** | **3** | **2** | **2** | **1** | | | **2** | | **1** | **2** |
| **CO4** | **3** | **3** | **3** | **2** | **2** | **1** | | | **2** | | **1** | **2** |

[Total No. of Pages : 2

B-248-02-03(a)

# M.Sc. DEGREE EXAMINATIONS, OCTOBER - 2021

## SECOND SEMESTER

**Branch : STATISTICS/APPLIED STATISTICS**

**Paper : III : ST-203 : LINEAR MODELS AND APPLIED REGRESSION ANALYSIS**

*(Under CBCS w.e.f. 2016-17)*

*(Common to supplementary Candidates also who appeared in 2015 and 2016 only with 70 marks)*

**Time : 3 Hours** **Max. Marks : 80**

## SECTION - A

Answer any **FOUR** questions. All questions carry **Equal** marks. (4×5=20)

1. In two variable linear regression model, prove that the sum of the residuals is zero.
2. Explain general linear model along with the underlying assumptions.
3. What is adjusted $R^2$ and explain its use.
4. Explain generalized mean squared error criterion.
5. Explain the model with non-normal disturbances and the consequences of the non normal disturbances.
6. Explain BLUS and predicted residuals.
7. Distinguish between 'linear' models and 'linearised' models with suitable examples. Explain Lagrange multiplier test.
8. Explain probit and multiple logistic regression models.

## SECTION - B

Answer **ALL** questions. Each question carries **15** marks. (4×15=60)

9. a) Derive the sampling distribution of the OLS estimator of a regression coefficient in general linear model and hence obtain the test statistic for testing the significance of the regression coefficient.

(OR)

b) In general linear model, derive the OLS estimator of the variance of the error term and show that it is unbiased. Also derive the sampling distribution of the estimator.

10. a) Obtain the restricted least squared estimator of $\beta$ in GLM $y = X\beta + \varepsilon$ with linear restrictions of the form $R\beta = r$, where R is a matrix of known constants and r is a vector of known constants.

(OR)

b) Derive the expression for coefficient of determination $R^2$ and obtain the F-test based on it.

11. a) Derive jarque-Bera test and Shapiro-Wilk test for normality and give their merits and demerits.

(OR)

b) Explain in detail

i. MAD estimation method and

ii. Box-Cox transformations

12. a) Distinguish between linear and non-linear regression models with suitable illustrations. Explain the ML and least square estimation methods of the parameters of the non-linear regression model.

(OR)

b) Explain various computational methods for obtaining the numerical estimates of the parameters of a non-linear regression model using ML method. Explain binomial logistic regression.

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## ST 203 (B) : COMPUTER PROGRAMMING – C++

UNIT-I: Object oriented programming principles, Declaration of classes, array of classes, Pointer to classes, constructors such as void constructor, copy constructor, Destructor,

UNIT-II: Friend functions, inline functions, static class members, this pointer, Single, Multiple inheritances: Types of derivation such as public, private, protected inheritance and member access controls, ambiguity in inheritance,

UNIT-III: Virtual base class, container classes. Function overloading, Operator Overloading, Overloading of assignment, binary, unary operators.

UNIT-IV: Polymorphism, Early binding, virtual functions, Late binding, pure virtual functions, abstract base classes, constructor under inheritance, destructor under inheritance, virtual destructors. Templates and Exception Handling. Data File operations, structures and file operations, classes and file operations.

**References**


1. R.Decker and So Hirshfield (1998): The Object Concept: An Introduction to Computer Programming using C++; PWS Publishing.
2. S.B.Lippmann and J.Lajoie (1998): C++ Primer. Third edition. Addison- Wesley. P.Nauahton (1996). The Java Handbook. Tata McGraw-Hill
3. W.J. Savitch (2001): Problem Solving with C++ The Object of Programming. Third Edition. Addison-Wesley Longman.
4. Deital&Deital: C++; Prentice-Hall Inc.
5. Sarang: Object Oriented programming with C++; Prentice-Hall Inc.
6. Balaguruswamy, E : Programming with C++; Tata McGraw-Hill.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| | | Theory | Practical | |
| **ST-203(B)** | **COMPUTER PROGRAMMING – C++** | 4 | ---- | 4 |
| Course Objective | 1. To get a good knowledge of object oriented programming principles.<br>2. To know about the Friend functions, Inline functions and multiple Inheritance in computer programming.<br>3. To learn the concpets of the Function overloading and operator overloading.<br>4. To teach the students about the polymorphism and exception handling. | | | |
| Course Out comes | 1. Students learn the concpets of the Object oriented programming principles in C++.<br>2. Students to use the concepts of the multiple inheritance in computer programming.<br>3. Students to have a clear idea about the overloading.<br>4. Students to have a clear knowledge of the exception handling. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **2** | **2** | | | | **2** | **2** | **1** | **1** |
| **CO2** | **3** | **2** | **1** | **2** | **2** | | | | **2** | **2** | **1** | **1** |
| **CO3** | **3** | **2** | **1** | **2** | **2** | | | | **2** | **2** | **1** | **1** |
| **CO4** | **3** | **2** | **1** | **2** | **2** | | | | **2** | **2** | **1** | **1** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

SECOND SEMESTER

**Branch : STATISTICS/ APPLIED STATISTICS**

203 (B): COMPUTER PRORAMMING-C++

(Under NEP 2021 )

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions All questions carry equal marks (Marks : 4 x 5 = 20)

PART-1

1. Explain Arrays
2. Describe Pointers
3. Write Abount Friend Functions
4. Explain Ambiguity In Inheritance.
5. Write About Binary Operators.
6. Write About Uniary Operators.
7. Describe Polymorphism.
8. Virtual Destructors.

SECTION – B

Answer any FOUR questions. Each question carries 15 marls. (Marks : 4 x 15 = 60)

9. Write About Object Oriented Programming.

Or

10. Write About The Copy Constructor And Destructor.
11. Explain Multiple Inheritances.

Or

12. Explain Protected Inheritance.
13. Write Briefly About The Function Overloading.

Or

14. Explain The Operator Overloading And Assignment.
15. Describe Destructor Under Inheritance.

OR

16. Explain Late Binding.

**ST 204 (A) : DESIGN AND ANALYSIS OF EXPERIMENTS**

**Unit-I**: Linear Model; Estimability of linear parametric functions; BLUE, Gauss-Markoff theorem; Generalized Gauss-Markoff theorem, ANOVA model, ANOVA for Two way and three way classifications, ANCOVA technique for one way and two-way classifications. Multiple comparisons tests using Tukey's, Duncans, Sheffe's and Dunnet's tests.

**Unit-II:** Latin squares and their construction, Mutually orthogonal Latin squares; Missing plot technique in Latin square Design, Graeco-Latin square Design; Analysis of Factorial Experiments involving factors with two and three levels in randomized blocks.

**Unit-III:** Necessity of confounding, Types of confounding, complete and partial confounding in $2^n$, $3^2$ and $3^3$ factorial designs, Analysis of confounded factorial designs; Fractional Replication, Split Plot design.

**Unit-IV:** Incomplete Block Designs; B I B D, Inter and Intra Block analysis of a BIBD, Types of BIBD, construction of BIBD's using Mutually orthogonal Latin squares; Concepts of Youden square and lattice Design, Two-Associate PBIB design, Analysis of P B I B design.

**References**


1. M.N. Das and N.C.Giri (1979), Design and Analysis of Experiments, Wiley, Eastern, Pvt. Ltd., New Delhi.
2. C.D. Montgomery (1976), Design and Analysis of Experiments, Wiley & Sons, New York
3. M.C.Chakbravarthy, (1962), Mathematics of Design of Experiments, Asia Publishing House, Calcutta.
4. Oscar Kempthrone (1974), The Design and Analysis of Experiments, Wiley Eastern, Pvt. Ltd., New Delhi.
5. W.T. Federer (1972), Experimental Designs Theory and Application, Mac Millan Company, New York.
6. Angela Dean and Daniel Ross (1999), Design and Analysis of Experiments, Springer-Verlag.
7. D.D.Joshi (1987), Linear Estimation and Design of Experiments, Wiley Eastern, Pvt. Ltd., New Delhi.
8. P.W.M.John (1971), Statistical Design and Analysis of Experiments, Macmillan
9. F.Pukelshiem (1993), Optimal Design of Experiments, Wiley & Sons
10. D.Raghava Rao (1971), Construction and combinatorial problems in Design of Experiments, Wiley & Sons
11. Aloke Day (1986), Theory of Block Designs, Wiley Eastern, Pvt. Ltd., New Delhi.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 204** | **Design and Analysis of Experiments** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To learn ANOVA and ANCOVA for one and two way classifications analysis and their multiple comparison tests. | | | |

| | |
|---|---|
| | 2. To explain Latin squares, different types of Latin squares and their missing plots.<br>3. To discuss on Confounding, their types, confounding $2^n$, $3^2$ and $3^3$ factorial designs etc.<br>4. To discuss about BIBD, PBIBD construction analysis. |
| Course Out comes | 1. Students learnt ANOVA, ANCOVA technique for one way and two-way classifications. Multiple comparisons tests using Tukey's, Duncans, Sheffe's and Dunnet's tests.<br>2. Students understood about Latin squares and their construction, missing plot technique etc.<br>3. Students explained about Incomplete Block Designs and their analysis, etc.<br>4. Understand the basic terms used in design of experiments by using appropriate experimental methods. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **2** | **3** | **1** | | | **2** | | **2** | **3** |
| **CO2** | **3** | **3** | **3** | **2** | **3** | **1** | | | **2** | | **2** | **3** |
| **CO3** | **3** | **3** | **3** | **2** | **3** | **1** | | | **2** | | **2** | **3** |
| **CO4** | **3** | **3** | **3** | **2** | **3** | **1** | | | **2** | | **2** | **3** |

B-248-03-02

M.Sc. DEGREE EXAMINATION — NOVEMBER/DECEMBER 2019

THIRD SEMESTER

Branch — Statistics

ST-204: Paper IV — DESIGN AND ANALYSIS OF EXPERIMENTS

*(Under CBCS w.e.f. 2017-2018)*

Time : 3 hours Max. Marks : 80

## SECTION - A

(Short Type Answer)

Answer any FOUR questions. Each question carries 5 marks.

(Marks : 4 × 5 = 20)

1. Define a linear model. Distinguish between linear and non linear models.
2. Explain the need for multiple comparisons with suitable example.
3. Explain the advantages of factorial experiments over single factor experiments.
4. Define mutually orthogonal Latin squares with an illustration.
5. Distinguish between complete and partial confounding.
6. What is fractional replication and give its importance?
7. Write a short note on incomplete block design.
8. Distinguish between inter and intra block of analysis of a BIBD.

## SECTION - B

(Essay Type Answer)

Answer All questions. Each question carries 15 marks.

(Marks : 4 × 15 = 60)

9. (a) State and prove Gauss-Markoff theorem.

Or

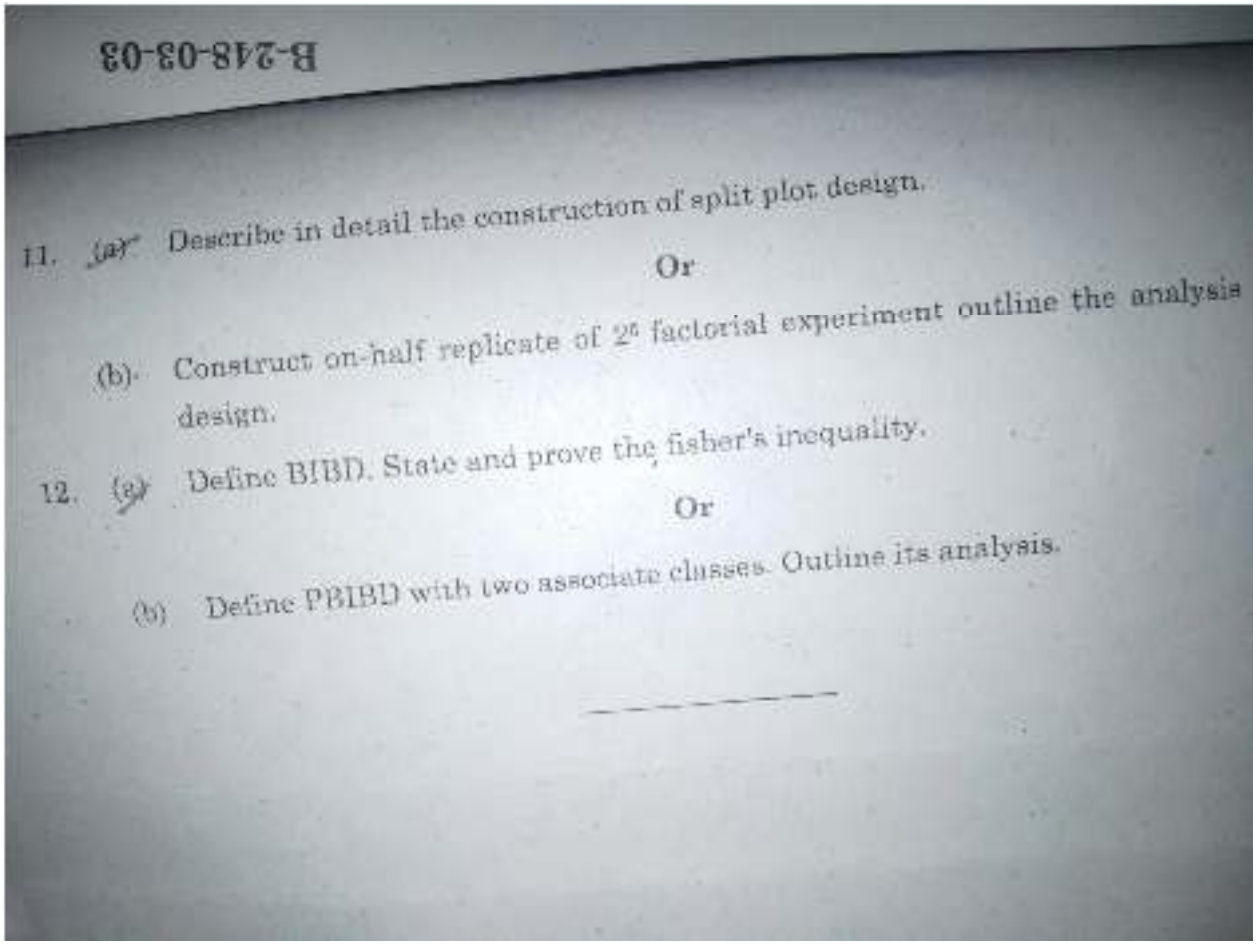
(b) Describe in detail about two-way classification ANCOVA technique with single concomitant variable.

10. (a) Explain the construction of $3^2$ factorial design in randomized blocks.

Or

(b) Describe the procedure of estimating single missing plot in Graeco Latin square design.

[P.T.O.]


B-248-03-03

11. (a) Describe in detail the construction of split plot design.

Or

(b) Construct on-half replicate of $2^6$ factorial experiment outline the analysis design.

12. (a) Define BIBD. State and prove the fisher's inequality.

Or

(b) Define PBIBD with two associate classes. Outline its analysis.

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**ST 204 (B) : INDUSTRIAL STATISTICS AND QUALITY CONTROL**

**UNIT-I:** General Theory of Control Charts: Control charts for attribute and variables: O.C. and A.R.L. of control charts; control by gauging; Moving average and exponentially weighted moving average charts; Cu-sum charts using V-masks and decision intervals. Capability indices: Cp, Cpk and Cpm.

**UNIT-II:** Acceptance sampling plans for attribute inspection: Single, double and sequential sampling plans; Plans for inspection by variables for one-sided and two-sided specifications;

**UNIT-III:** Mil Std and ISI plans; Continuous sampling plans of Dodge type and Wald-Wolfwitz type and their properties.

**UNIT-IV:** Industrial Experimentation, Fractional factorial experiments, Response surface methodology, Six sigma in process improvement and product development, Lean thinking, Value stream analysis, 5 s.

**Reference Books:**
1. Cowden D J (1957): Statistical Methods in Quality Control. 1st Edition. Prentice-Hall Inc.
2. Duncan Acheson (1986): Quality Control and Industrial Statistics. 5th Edition. Irvin Mittag and Rinne (1993): Statistical Methods for Quality Assurance. 2nd Edition. Chapman and Hall Ltd.
3. Montgomerv. D.C (2012): Introduction to Statistical Quality Control. 7th Edition. John Wiley and Sons
4. R.C. Guptha(2001): Statistical Quality Control. 9th Edition. Khanna Publishers.
5. Ott, E.R. (1975): Process Quality Control. 4th Edition. McGraw Hill
6. Phadke, M.S. (1989): Quality Engineering through Robust Design. 1st Edition. Prentice Hall
7. Wetherill, G.B. (1977): Sampling Inspection and Quality Control. 2nd Edition. Chapman and Hall Ltd.

8. Wetherill, G.B. and Brown, D.W.(1991): Statistical Process Control. Theory and Practice. 3rd Edition. Chapman & Hall Ltd.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 204** | **Industrial Statistics and Quality control** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. Able to understand basics of production process monitoring and apply concept of control charts to it.<br>2. Apply acceptance and continuous sampling plan in production process.<br>3. Able to construct sampling inspection plans for attributes and variables.<br>4. Able to learn some advanced control charts and capability indices.Able to construct Six Sigma limits. | | | |
| Course Out comes | 1. Can identify the cause of defects using statistical quality management techniques.<br>2. Able to apply statistical quality control techniques to minimize the<br>3. variability in manufacturing and business process.<br>4. Acquainted with Six Sigma and lean thinking in industrial experimentation.<br>5. Expertise in the most import field of applied statistics that contributes to quality control in all most all industries. | | | |

# Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **1** | **3** | **2** | | | **1** | **1** | **2** | **1** |
| **CO2** | **3** | **2** | **2** | **1** | **3** | **2** | | | **1** | **1** | **2** | **1** |
| **CO3** | **3** | **2** | **2** | **1** | **3** | **2** | | | **1** | **1** | **2** | **1** |
| **CO4** | **3** | **2** | **2** | **1** | **3** | **2** | | | **1** | **1** | **2** | **1** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

SECOND SEMESTER

**Branch : STATISTICS**

ST 204 (B) INDUSTRIAL STATISTICS AND QUALITY CONTROL

(Under NEP 2021 )

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions All questions carry equal marks (Marks : 4 x 5 = 20)

1. Explain Shewart Control Chart.
2. Describe V-Mask.
3. Write About The Single Sampling Plan.
4. Write Briefly About The Double Sampling Plan.
5. Explain Nil Std Plan.
6. Write About Wald-Wolfwitx Type.
7. Explain Fractional Factorial Experiments.
8. Write About The Lean Thinking.

SECTION – B

Answer any FOUR questions. Each question carries 15 marks. (Marks : 4 x 15 = 60)

PART-2

9. Write About The Exponentially Weights Moving Average Chart.

Or

10. Explain Cp, Cpk And Cpm.
11. Write Briefly About Sequential Sampling Plan.

Or

12. Explain Two Sided Specification With An Example.
13. Write About Continues Sampling Plan.

Or

14. Write About Nil Std And Lss Plan.
15. Write About The Six Sigma Process.

Or

16. Explain Response Surface Methodology.

**ST 205 : PRACTICAL-III**

At least 24 practicals covering all papers relating to the subject in this semester must be carried out. (75 marks for practical examination + 15 marks for viva-voce + 10 marks for record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-205** | **PRACTICALS** | Theory | Practical | 4 |

| | | | | |
|---|---|---|---|---|
| | | ---- | 4 | |
| Course Objective | 1. To exercise different practical problems manually through calculators.<br>2. To discuss problems relates to semester - II papers.<br>3. To Know the real life problems of the Industtrial sector and quality control.<br>4. To Solve the agriculture related problems of using statistical methods. | | | |
| Course Out comes | 1. Students know about the solving of Numerical problems related to Multivariate data.<br>2. Students can solve the theoretical problems in simple way by using c-programming.<br>3. They can also use the statistical tools and techniques for analyzing the statistical data.<br>4. Students can solve the agriculture related problems using the Regression Methods. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO2** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO3** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO4** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |

### ST 206 : PRACTICAL-IV

At least 20 practicals covering all papers relating to the subject in this semester must be carried out. (75 marks for practical examination + 15 marks for viva-voce + 10 marks for record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-206** | **PRACTICALS** | Theory | Practical | 4 |
| | | ---- | 4 | |
| Course Objective | 1. To exercise different practical problems manually through calculators.<br>2. To discuss problems relates to semester - II papers.<br>3. To Solve the problems using the concept of Design of Experiments.<br>4. To fitr the linear model techniques for the data. | | | |
| Course Out comes | 1.Students know about the solving of numerical problems related to linear models and regression analysis.<br>2.Students can solve the problems related to agricultural data by using the concepts of design and analysis of experiments.<br>3.They can know how to fit the linear models techniques used to solve | | | |

| | |
|---|---|
| | the data.<br>4.Students may have the knowledge of solving industrial statistical data by using the concepts of statistical quality control. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO2** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO3** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO4** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |

# SEMESTER – III

### ST 301: ECONOMETRIC METHODS

**Unit-I:** Quick review of Inference in general linear model; multi collinearity; Sources and consequences; detection, Farrar-Glauber Test; remedies, Ridge family of estimators and its properties; Heteroscedasticity; sources and consequences; Tests for Heteroscedasticity; Glejser's test Goldfeld-Quandt test; remedies, estimation under Heteroscedasticity.

**Unit-II:** Autocorrelation; sources and consequences; first order auto regressive Scheme; Durbin-Watson test; Remedies; Estimation under autocorrelation; Stochastic Regressors; Errors-in-Variables linear model; IV and ML estimation methods.

**Unit-III:** Finite Distributed lag models; Arithmetic lag; Inverted V-lag; Almon's Polynomial lag and Shiller's lag models; Infinite distributed lag models; Geometric lag model; OLS and IV methods of estimation; Koyek's two step and Wallis three step procedures; Pascal lag model.

**Unit-IV:** Simultanious linear equations models; identification; rank and order conditions; indirect least squares, IV and LIML methods; two stage least squares; k-class estimators; three stage least squares and FIML methods of estimation.

## References


1. Johnston, J (1984): Econometric Methods, III rd Edition, MC Graw Hill.
2. Judge, C.G., Griffths, and Hill, R.C. et al (1985): Theory and Practice of Econometrics, John Wiley.
3. Gujarathi, D (1979): Basic Econometrics, Mc Graw hill.
4. Intrilligator, M.D (1980): Econometric Models, Techniques and Applications, Prentice Hall.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-301** | **ECONOMETRIC METHODS** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To explain about heteroscedasticity, multicollinearity and their sources, consequences and tests.<br>2. To discuss about Autocorrelation, different orders of Autocorrelation and their estimation procedures.<br>3. To explain different lag models and their estimate procedures.<br>4. To discuss about simultaneous linear equations model and their different methods and estimation. | | | |
| Course Out comes | 1. Students learnt heteroscedasticity, multicollinearity and autocorrelation and their estimation procedures.<br>2. Students understood about different lag models and simultaneous linear equations model with their estimation methods.<br>3. Explain core concepts and techniques in econometrics, with a special focus on the classical linear regression model.<br>4. Understand the assumptions upon which different econometric methods are based and their implications. | | | |

# Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **2** | **3** | **1** | | | **1** | | **2** | **2** |
| **CO2** | **3** | **2** | **1** | **2** | **3** | **1** | | | **1** | | **2** | **2** |
| **CO3** | **3** | **2** | **1** | **2** | **3** | **1** | | | **1** | | **2** | **2** |
| **CO4** | **3** | **2** | **1** | **2** | **3** | **1** | | | **1** | | **2** | **2** |

M.Sc. DEGREE EXAMINATION — NOVEMBER/DECEMBER 2019.

THIRD SEMESTER

**Statistics**

**Paper I — ECONOMETRIC METHODS**

(Under CBCS w.e.f. 2017-2018)

Time : 3 hours

Max. Marks : 80

SECTION – A

(Short type answer)

Answer any FOUR questions. Each question carries 5 marks.

(Marks : $4 \times 5 = 20$)

1. Write about (a) VIF and (b) Eigen system analysis.

2. Give an account on Heteroscedasticity and give its consequences.

3. Define Stochastic Regressors with an example.

4. Briefly explain ML method of estimation.

5. Write a short notes on Shiller's lag model.

6. What do you mean by finite distributed lag models?

7. Give an account of indirect least squares.

8. Briefly describe about identification and rank of simultaneous linear equation.

SECTION – B

Answer any FOUR questions. Each question carries 15 marks.

(Marks : $4 \times 15 = 60$)

9. (a) Define Multicollinearity. Explain in detail about Ridge regression.

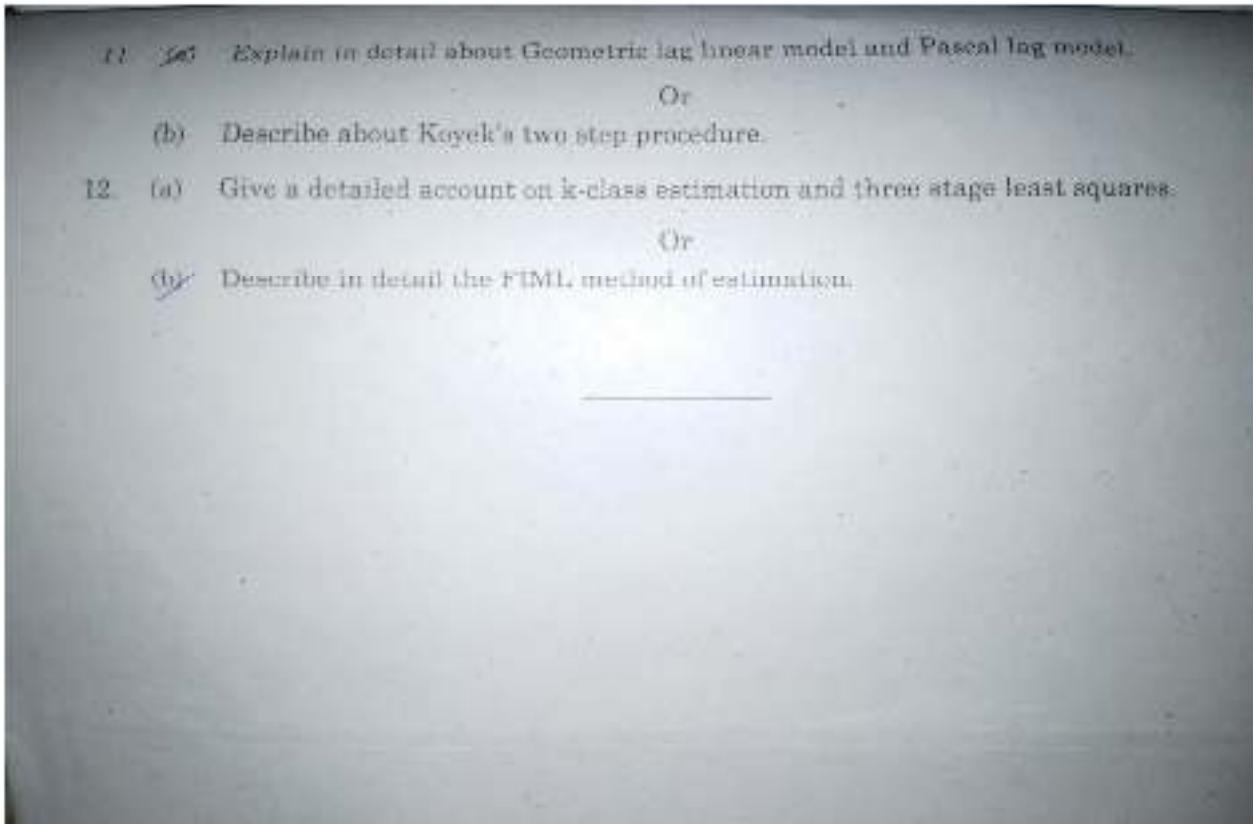
Or

(b) Describe Farrar-Glauber test and Glejser's test.

10. (a) What do you mean by Errors-in-model? Describe in detail about IV method of estimation.

Or

(b) Explain in detail about Durbin-Watson test. Describe the consequences of Autocorrelation.



11 (a) Explain in detail about Geometric lag linear model and Pascal lag model.

Or

(b) Describe about Koyck's two step procedure.

12. (a) Give a detailed account on k-class estimation and three stage least squares.

Or

(b) Describe in detail the FIML method of estimation.

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**ST 302: OPERATIONS RESEARCH – I**

**Unit-I:** Definition and scope of Operations research; phases in Operations Research; models and their solutions (Review of Linear Programming). Definition of Dual-Primal, Relationships- Dual Simplex Sensitivity or Post Optimal Analysis, Revised Simplex method.

**Unit-II:** Non-linear programming - Kuhn Tucker conditions. Wolfe's algorithm for solving quadratic programming problems. Integer programming – Branch and bound algorithm and cutting plane algorithm.

**Unit-III:** Flows in networks max-flow-min-cut theorem. Project Management; PERT and CPM probability of project completion, PERT – crashing.

**Unit-IV:** Decision making in the face of competition, two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero- sum games, finding solution in 2x2, and 2xm, and mxn games. Non – zero sum games, co-operative and competitive games, equilibrium solutions and their existence in bi- matrix games. Nash equilibrium solution.

**References**


1. Taha H.A (1982) Operational Research: An Introduction; Macmillan.
2. Hiller F. Sand Leiberman G.J. (1962) Introduction to Operations Research; Holden Day
3. Kanti Swarup; Gupta P.K and Singh M.M (1985) Operations Research; Sultan Chand.
4 .Philips D.T, Ravindran A and Solberg J Operations Research, Principles and Practice.
5. Curchman C.W; Ackoff R.L and Arnoff E.L(1957) introduction to Operations Research; John Wiley
6. Hadley G (1964) Non-Linear and Dynamic programming Addison Weslay.
7. Mckinsey J.C.C(1952) Introduction to the theory of games Mc Graw Hill.P.K.Gupta; D.S.Hira Operations Research S.CHand.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-302** | **Operations Research-I** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To introduce operations research, Dual-primal, Revised simplex methods.<br>2. To discuss Non-linear programming and integer programming and their related problems.<br>3. To explain Network flow charts, CPM and PERT, project management models.<br>4. To discuss Game theory of 2×2, 2×m, m×n and non-zero-sum games with their illustrations. | | | |
| Course Out comes | 1. Students understood about Dual primal, Revised simplex methods.<br>2. Students learnt non-linear programming, integer programming, CPM, PERT, different models of games.<br>3. Students can think the real-life problems in the way of Linear Programming Problems and try to solve the problems in Mathematical Way.<br>4. Students can take a decision in real life by Using the Game Theory Techniques. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO2** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO3** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |

B-248-05-08

M.Sc. DEGREE EXAMINATION — NOVEMBER/DECEMBER 2019

THIRD SEMESTER

**Branch — Statistics**

**Paper-II : ST-302 — OPERATIONS RESEARCH – I**

*(Under CBCS & Non-CBCS w.e.f. 2017-2018)*

Time : 3 hours Max. Marks : 80

## SECTION - A

**(Short Type Answer)**

Answer any FOUR questions. Each question carries 5 marks.

(Marks : $4 \times 5 = 20$)

1. Describe the phases involved in constructing LP problem.
2. Define Duality with an example. Show that the dual of the dual LP problem is primal.
3. What is meant by quadratic programming? How does a quadratic programming problem differ from a linear programming problem?
4. Write down the steps involved in Wolfe's algorithm for solving a quadratic programming problem.
5. Write a short notes on Forward and Backward pass methods in critical path analysis.
6. Draw an arrow diagram of activities of the project :

| Activity : | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Predecessor activity : | — | A | A | C | B, C | D, E | E | G | D, F | I, H | K |

7. For the M/M/1 : (FIFO) model, derive the steady state equations and solve them.
8. Define the following terms :
   (a) Queue discipline
   (b) Arrival and service pattern with example.

## SECTION - B

**(Essay Type Answer)**

Answer ALL questions. Each question carries 15 marks.

(Marks : $4 \times 15 = 60$)

9. (a) Solve the following LP problem using an appropriate method :

Maximize $z = 2x_1 + x_2 + x_3$

Subject to

$x_1 + x_2 + 2x_3 \leq 5$

$2x_1 + 3x_2 + 4x_3 = 12$ and

$x_1, x_2, x_3 \geq 0$.

**Or**

[P.T.O.]

(b) Use the revised simplex method to solve the following LP problem:

Maximize $z = x_1 - x_2 + 2x_3$

Subject to

$3x_1 + 2x_2 - x_3 \leq 3$

$2x_1 + x_2 + 2x_3 = 2$ and

$x_1, x_2, x_3 \geq 0$.

10. (a) What are Kuhn-Tucker conditions associated with non-linear programming problem? Prove the sufficiency theorem of Kuhn-Tucker conditions.

Or

(b) Describe the steps involved on :

(i) Gomory's cutting plane algorithm and

(ii) Branch and Bound algorithm.

11. (a) A project is represented by the network shown below and has the following data :

| Task | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| Optimistic time : | 5 | 18 | 26 | 16 | 15 | 6 | 7 | 7 | 3 |
| Pessimistic time : | 10 | 22 | 40 | 20 | 25 | 12 | 12 | 9 | 5 |
| Most likely time : | 8 | 20 | 33 | 18 | 20 | 9 | 10 | 8 | 4 |

Determine the following :

(i) Expected task time and their variance

(ii) The earliest and latest expected time to reach each event.

(iii) The critical path.

Or

(b) Two food manufacturers, ABC and XYZ are competing for an increased market share. The payoff matrix, shown in the following table, shows the increase in market share for ABC and decrease in market share for XYZ.

| ABC | XYZ | | | |
|---|---|---|---|---|
| | Give Coupons | Decrease price | Maintain present strategy | Increase advertising |
| Give Coupons | 2 | -2 | 4 | 1 |
| Decrease price | 6 | 1 | 12 | 3 |
| Maintain present strategy | -3 | 2 | 0 | 6 |
| Increase advertising | 2 | -3 | 7 | 1 |

Simplify the problem by the rule of dominance and find the optimal strategies fo both the manufactures and the value of the game.

## ST 303 (A) : DEMOGRAPHY AND OFFICIAL STATISTICS

**Unit-I:** Nature, Scope and limitations of demography; Sources of Demographic data in India; Measures of Mortality; life-tables; construction of abridged life table; Measures of fertility Stochastic models for reproduction, Reproduction rates: GRR and NRR; Concepts of Migration and Urbanization.

**Unit-II:** Population Projections: Stable and Stationary populations, Lotka's model; Use of Leslie matrix. Population estimates; Chandrasekhar and Deming's method, component method, Stochastic models of population growth, Exponential and logistic population growth models: Birth and death model, Birth-death and migration model.

**Unit-III:** Population Genetics: Concepts of Genotypes and Phenotypes; Basic Mating from Single gene cross, Punnet Square method, Mendal's laws of heredity; Random mating; Hardy-Weinberg Equilibrium law; Calculation of Gene frequencies, Estimation of Gene frequencies in ABO blood group system.

**Unit-IV:** Statistical systems in India; CSO, NSSO and their functions; scope and content of population Census in India; Methods of conducting population census, Economic census and Agricultural census in India and defects; Sources of forest statistics.

### References


1. Suddender Biswas (1988), Stochastic Process in Demography and Applications, Wiley Eastern Ltd, New Delhi.
2. K.B. Pathak and F. Ram (1992), Techniques of Demographic Analysis, Himalayan Publishing House, Bombay.
3. Osacr Kempthorne (1973), An Introduction to Genetic Statistics, Jagmohan Book Agency, New Delhi.
4. William D. Stansfield (1969), Theory and Problems of Genetics, Schaum's Outline Series, MC Graw Hill, New York.
5. B.N. Gupta (1994), Statistics, Sahitya Bhavan, Agra.
6. B.L. Agrawal (1994), Basic Statistics, 2nd Edition, Wiley Eastren, New Delhi.
7. Asthana ( 1970), Indian Official Statistics.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 203(b)** | **Demography and** | Theory | Practical | 4 |

| | official statistics | 4 | ---- | |
|---|---|---|---|---|
| Course Objective | 1. To study about demography and their importance, different reproduction.<br>2. To explain population Genetics, CSO, NSSO and their scope and contents in population census in India.<br>3. To learn the concepts of the population growth models and population estimates.<br>4. To know the difference between economic census and agiculture census. | | | |
| Course Out comes | 1. Students know the growth rates, life tables, GRR, NRR and growth models.<br>2. Students understood about gene frequencies, genotypes, phenotypes etc.<br>3. Students learnt about population census methods, organizations in India and their functions.<br>4. Useful to students as a means of analyzing and predicting social, cultural, and economic trends related to population. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **2** | **2** | **1** | | | **2** | | **1** | **1** |
| **CO2** | **3** | **2** | **2** | **2** | **2** | **1** | | | **2** | | **1** | **1** |
| **CO3** | **3** | **2** | **2** | **2** | **2** | **1** | | | **2** | | **1** | **1** |
| **CO4** | **3** | **2** | **2** | **2** | **2** | **1** | | | **2** | | **1** | **1** |

B-248-04-02

M.Sc. DEGREE EXAMINATION — APRIL/MAY 2019

FOURTH SEMESTER

**Branch: Statistics**

DEMOGRAPHY AND OFFICIAL STATISTICS

*(Under CBCS w.e.f. 2017-2018)*

Time : 3 hours Max. Marks : 80

SECTION – A

Answer any FOUR questions. Each question carries 5 marks.
(Marks : $4 \times 5 = 20$)

1. Write a short notes on Neonatal Mortality rate.

2. Explain Gross reproduction rate (G. R. R.).

3. Distinguish between stationary and stable population.

4. Explain the logistic population growth models.

5. Write a short notes on Punnet square method.

6. Explain the Mendal's laws of heredity.

7. Explain the functions of CSO.

8. Write the short notes on source of forest statistics.

SECTION – B

Answer ALL questions. Each question carries 15 marks.
(Marks : $4 \times 15 = 60$)

9. (a) Explain the construction of Abridged life table.

Or

(b) Explain the various measures of fertility rates.

[P.T.O.]

10. (a) Explain the component method by use of the Leslie matrix.

Or

(b) Explain the generalized birth and death process models.

11. (a) State and prove the Hardy — Weinberg equilibrium law.

Or

(b) Explain the calculation of Gene frequencies with an example.

12. (a) Explain various methods of conducting population census.

Or

(b) Explain the economics census and agriculture census in India.

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## ST 303 (B) : BIO-STATISTICS

**Unit-I:** Structure of Biological assay, Types of Biological assays: Direct assays, Potency ratio, Fieller's theorem, Behren's distribution, Two generalizations of Fieller's theorem.

**Unit-II:** Quantitative dose-response relationships, Linear dose-response regression, Parallel line bioassay, Slope Ratio Bioassay, Quantal responses, Estimation of median effective dose, Transformations: Probit and Logit transformations.

**Unit-III:**: Basic Biological concepts: Gene, Chromosomes, Alleles, Concepts of Geno types and Phenotypes, Family studies, Basic mating from single gene cross, Matrix approach to basic matings of single gene cross, Checker board method, Mendal's law of heredity: Geneotypes and Pheno type ratios, Branching system method.

**Unit-IV:** Types of matings, Random Mating, Concept of Gene pool, Gene frequency, Hardy–Weinberg law of equilibrium, Calculation of Gene frequencies, Genotypic frequency, Generation matrix approach to inbreeding, Estimation of Gene frequencies in ABO blood group system, Maximum Likelihood Method, Minimum Chi-Square method, Genetic parameters; Heritability Coefficients, Genetic Correlations, Repeatability, selection index; Inbreeding coefficient.

**References**


1. D.J. Finney (1971): Statistical Methods in Biological Assay, Charles Griffen and Company, London.
2. D.J. Finney (1971): Probit Analysis, 3rd Edition, S.Chand and Company Ltd, New Delhi.
3. William D. Stansfield. (1969): Theory and Problems of Genetics, Schaum's Outline Series, MC Graw Hill, New York.
4. Oscar Kempthorne (1973): An Introduction to Genetic Statistics, Jagmohan Book agency, New Delhi.
5. J.P. Jain (1992): Statistical Techniques in Quantitative Genetics, 2nd Edition, Hindustan Publishing House, New Delhi.
6. Basu, S. B. (1996), Quantitative Genetics Research Technique, Kalyani Publishers, New Delhi.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 304 (b)** | **Bio-Statistics** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To understand about biological assay and their types, distribution and some of theorems.<br>2. To learn dose response relationships, their estimation, transformations.<br>3. To discuss Geno types and phenol types, Matrix operations to base mattings of single gen cross etc. | | | |

| | |
|---|---|
| | 4. To estimate Gene frequency using different methods. |
| Course Out comes | 1. Students learnt about biological assay, their distribution and theorems, dose response relationships, basic concepts of biological assay, estimation methods of gene frequencies, etc.<br>2. Describe single and multi-species population growth models.<br>3. Apply the concept of deterministic and stochastic models on simple and general epidemics.<br>4. Understand linearization of dynamical systems with various dimensions. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **1** | **2** | **1** | | | **2** | | **2** | **3** |
| **CO2** | **3** | **3** | **2** | **1** | **2** | **1** | | | **2** | | **2** | **3** |
| **CO3** | **3** | **3** | **2** | **1** | **2** | **1** | | | **2** | | **2** | **3** |
| **CO4** | **3** | **3** | **2** | **1** | **2** | **1** | | | **2** | | **2** | **3** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

FIRST SEMESTER

**Branch : STATISTICS**

ST 303 (B) BIO STATISTICS

(Under NEP 2021 )

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions All questions carry equal marks (Marks : 4 x 5 = 20)

1. Explain Types Of Biological Allays.
2. Write About Potential Ratio.
3. Explain About Quantal Responses.
4. Write About Profit Transformations.
5. Explain Branching System Method.
6. Explain Checker Board Method.
7. Write About Random Mating.
8. Write About Heritability Coefficients.

SECTION – B

Answer any FOUR questions. Each question carries 15 marks. (Marks : 4 x 15 = 60)

PART-2

9. State And Prove Fieller's Theorem.

Or

10. Explain Behren's Theorm.
11. Describe Slope Ratio Bioassay.

Or

12. Write About Linear Desc Response Regression.
13. Write About Matrix Approach To Basic Mactings Of Single Gene Cross.

Or

14. Write About Mendal's Law Of Heredity.
15. Explain Hardy-Weinberg Law Of Equilibrium.

Or

16. Write About Minimun Chi Square Method.

**ST 304 : PRACTICAL-V**

At least 20 practicals covering all papers relating to the subject in this semester must be carried out. (75 marks for practical examination + 25 marks for Record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-304** | **PRACTICAL** | Theory | Practical | 4 |
| | | ---- | 4 | |
| Course Objective | 1. To solve the different practical problems manually through calculators and computers.<br>2. To do the Practical problems related to semester - III papers.<br>3. To construct the life tables.<br>4. To solve the numerical problems relating to Operations Research. | | | |
| Course Out comes | 1. Students can understand the Statical Methos in Economical Views.<br>2. Students solved the Numerical problems related to operations research.<br>3. Students Understand the Life Tables in Demography.<br>4. Students can understand how the statistics use in biological aspects.<br>. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO2** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO3** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |
| **CO4** | **3** | **3** | **2** | **3** | **3** | | | | **2** | **2** | **3** | **1** |

## ST 305 : STATISTICAL ANALYSIS USING R + R PRACTRICALS

## PRACTRICALS - VI

## R PROGRAMMING

**UNIT-I**: Familiarizing with R environment, Using R console as a calculator, R atomic types, methods of creating vectors, combining vectors and repeating vectors, different ways of subsetting vectors using indexing, names and logicals. Arithmetic and logical operations. Using character vectors for text data, manipulating text using strsplit(), paste(), cat(), grep(), gsub() functions; handling factor data. Working with dates.

**UNIT – II**: Creating Matrices, getting values in and out of matrices, performing matrix calculations; Working with multidimensional Arrays; creating data frames, getting values in and out of data frames, adding rows to data frame, adding variables to data frame; creating lists, extracting components from a list, changing values of components of lists. Getting data into and out of R - reading data in CSV files, EXCEL files, SPSS files and working with other data types. Getting data out of R – working with write.csv() and write.table() functions.

**UNIT – III:**Writing Scripts and functions in R. writing functions with named, default and optional arguments. functions using as arguments. Debugging your code. Control statements in R – conditional control using if, if-else, ifelse; looping control using for, while, repeat; transfer of control using break and next. Manipulating and processing data - creating subsets of data, use of merge() function, sorting and ordering of data. Group manipulation using apply family of functions - apply, sapply, lapply, tapply.

**UNIT – IV**: Base graphics. Use of high-level plotting functions for creating histograms, scatter plots, box-whiskers plot, bar plot, dot plot, Q-Q plot and curves. Controlling plot options using low-level plotting functions - Adding lines, segments, points, polygon, grid to the plotting region; Add text using legend, text, mtext; and Modify/add axes, Putting multiple plots on a single page.

**UNIT - V** - Working with probability distributions - normal, binomial, Poisson and other distributions. Summary statistics, hypothesis testing - one and two-sample Student's t-tests, Wilcoxon U-test, paired t-test, paired U-test, correlation and covariance, correlation tests, tests for association- Chi-squared test and goodness-of- fit tests. Formula notation, one-way and two-way ANOVA and post-hoc testing, graphical summary of ANOVA and post-hoc testing, extracting means and summary statistics; linear regression.

**References:**


1. Mark Gardener(2012), Beginning R - The Statistical Programming Language, Wiley India Pvt Ltd.
2. Andrie de Vries and JorisMeys(2015), R Programming for Dummies, Wiley India Pvt Ltd.
3. Jared P. Lander(2014), R For Everyone - Advanced Analytics and Graphics, Pearson Education Inc.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST-305** | **STATISTICAL ANALYSIS USING R** | Theory | Practical | 4 |
| | | ---- | 4 | |
| Course Objective | 1. Able to create and manipulate vectors, matrices, arrays, data frames and lists.<br>2. Should be able to work with character data, factor data and dates.<br>3. Able to write scripts and function in Rand read data from. csvfiles, EXCEL files And SPSS files.<br>4. Able to distinguish between high-level and low level plotting functions available in base R. | | | |
| Course Out comes | 1. Students can manipulate the vectors, matrices, arrays, data frames and lists.<br>2. Students can work with the character data, factor data and dates.<br>3. Students get the results using data in R.<br>4. Students can work with different distributions and apply different tests for the data using R. | | | |

# Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | **3** | **1** | | | **2** | **1** | **2** | **1** |
| **CO2** | **3** | **3** | **3** | **3** | **3** | **1** | | | **2** | **1** | **2** | **1** |
| **CO3** | **3** | **3** | **3** | **3** | **3** | **1** | | | **2** | **1** | **2** | **1** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **1** | | | **2** | **1** | **2** | **1** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

THIRD SEMESTER

**Branch : STATISTICS**

ST-305: STATISTICAL ANAYSIS USING R

(Under NEP 2021 ) .

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions All questions carry equal marks (Marks : 4 x $2^1/_2$= 10)

1. Explain logical operations using R.
2. Write about vectors, addition, subtraction and multiplication using R.
3. Explain creating lists and changing values of components of lists.
4. Write about data frames and adding rows to data frames with example.
5. Describe while, repeat with examples.
6. Explain functions sorting and ordering data.
7. Describe students t-test.
8. Explain ANOVA using R.

SECTION – B

Answer any FOUR questions. Each question carries $7^1/_2$marls. (Marks : 4 x $7^1/_2$= 60)

9. (a) Write about Arithmetic operations in Excel using R
   (or)
   (b) Explain matrix calculations, Add, Subtraction and multiplication in R
10. (a) Explain control statements in R with example.
    (or)
    (b) Write about family of functions in R.
11. (a) Explain a Q-Q-plot, histogram, bar plot with illustrations.
    (or)
    (b) Write about putting multiple plots on a single page.
12. (a) Explain Students t-tests using R.
    (or)
    (b) Describe two way ANOVA using R.

## ST 306 (A): STATISTICS FOR BIOLOGICAL AND EARTH SCIENCES

**Unit - I:** Statistical measures: Statistical diagrams and graphs; Frequency distributions; Measures of central tendency: Arithmetic mean, Median and Mode; Measures of variation:

Range, Quartile Deviation, Mean Deviation, Standard deviation, Coefficient of variation; Karl Pearson's coefficient of Skewness.

**Unit- II :** Random Variable and Probability Distributions: Definition of Probability, Additive and Multiplicative laws of probability (statements only), Random variable, Binomial, Poisson, Normal and Exponential distributions (properties and applications), Curve Fitting: Principle of least squares; Fitting of a straight line, Exponential curve and Power curve; Correlation and Regression Analysis: Karl Pearson's coefficient of correlation, Spearman's Rank correlation coefficient; Simple linear regression; Multiple and Partial correlation coefficients; Multiple linear regression; Yules coefficient of Association.

**Unit –III:** Tests of Significance: Basic concepts; Z- test for proportions and means; Applications of t, $\chi^2$ and F tests; Paired t-test; Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) techniques for one way and two way classifications (single observation per cell), Confidence limits.

**Unit- IV**: Special Statistical Tools: Experimental designs CRD, RBD and LSD and their analysis; concept of critical difference; Duncan's Multiple range test; Elements of Principal components Analysis, Factor Analysis; Cluster Analysis and Discriminant analysis; Hotelling's $T^2$ and Mahalanobis $D^2$ statistics; Multivariate Analysis of Variance (MANOVA); Canonical correlations; Concept of Probit analysis.

**References**


1. Bailey, N.T.J.(1959), Statistical Methods in Biology, The English Universities Press Ltd.,
2. Pillai, S.K., and Sinha, H.C.(1968), Statistical Methods for Biological workers, Ram Prasad and sons, Agra.
3. Basu, S.P.(1996), Quantitative Genetics Research techniques, Kalyani publishers, New Delhi.
4. Misra, B.N., and Misra, M.K.(1998), Introductory Practical Biostatistics, Naya Prakash, Kolkata.
5. Johnson, R.A., and Wichern, D.W.(2001), Applied Multivariate Statistical Analysia, Third edition, Prentice Hall of India, New Delhi.
6. Federer, W.T.(1963), Experimental Designs and its applications, Macmillon.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 306 (a)** | **Statistics for Biological and Earth sciences** | Theory | Practical | 4 |
| | | 4 | ---- | |

| | |
|---|---|
| Course Objective | 1. To learn basic statistics and their worked out examples.<br>2. To discuss about different tests like t, F, $\chi^2$ and Z fro means, proportions, variances, standard deviation etc. with illustrations.<br>3. To explain ANOVA and ANCOVA for one way and two way classification and their importance in analysis.<br>4. To discuss Special statistical tools and multivariate analysis. |
| Course Out comes | 1. Students learnt about Graphs, measures of averages, measures of dispersion etc.<br>2. Students understood about Basic probability and important distributions with workout examples.<br>3. Students used t, F, $\chi^2$ , ANOVA and ANCOVA and non-parametric tests with examples.<br>4. Students used Advanced statistics tools with working illustrations. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **1** | **2** | **1** | **2** | | **1** | | **2** | **1** |
| **CO2** | **3** | **2** | **1** | **1** | **2** | **1** | **2** | | **1** | | **2** | **1** |
| **CO3** | **3** | **2** | **1** | **1** | **2** | **1** | **2** | | **1** | | **2** | **1** |
| **CO4** | **3** | **2** | **1** | **1** | **2** | **1** | **2** | | **1** | | **2** | **1** |

### ST 306 (B): STATISTICS FOR SOCIAL AND BEHAVIOURAL SCIENCES

**Unit- I:** Statistical Measures: Measures of central tendency: Arithmetic Mean, Median and Mode; Measures of Variation: Range, Quartile Deviation, Standard Deviation, Coefficient of Variation, Measures of Skewness.

**Unit- II:** Probability and Distributions: Concept of Probability, Laws of Probability (statements only); Random Variable; Probability Distributions: Binomial, Poisson and Normal distributions (properties and applications).

**Unit- III:** Tests of Significance: Basic concepts; Random sampling techniques; Standard error of statistic; Large sample tests for proportions and means; Small sample tests: Applications of t, $\chi^2$ and F tests; Analysis of Variance (ANOVA) and Analysis of Covariance

(ANCOVA) techniques for one way and two way classifications (single observation per cell); Nonparametric tests: Wilcoxon Signed Rank test, Median test and Mann-Whitney U-test.

**Unit- IV:** Special statistical tools: Computation of Linear and Compound Growth rates and their tests of significance; Chow test for Structural change; Granger Causality test; Stepwise regression; $R^2$ and $\overline{R}^2$statistics; Multiple Range tests: l.s.d. test and Duncan's test: ANOVA for Ranked data; Krushkal-wallis test, Friedman test; Elements of Factor analysis and Discriminant analysis.

**References**


1. Gupta, S.C.(1997), Fundamentals of Statistics, Himalayan Publishers, Mumbai.
2. Kshirasagar, A.M. (1972), Multivariate Analysis, Marcel Decker, New York.
3. Gujarati, D.(1995), Basic Econometrics, Mc Graw Hill.
4. Ferguson, C.A.(1971), Statistical Analysis in Psychology and Education, McGraw Hill.
5. Johnson, R.A., and Wichern, D.W. (2001), Applied Multivariate Statistical Analysis, Third Edition, Prentice-Hall of India (p) Ltd.,. New Delhi.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 306 (b)** | **Statistics for social and behavioral sciences** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To learn about Basic statistics measures with examples.<br>2. To discuss important concepts, probability distributions like Binomial, Poisson and Normal properties and applications.<br>3. To explain Parametric and non-parametric test and discussed with illustrations.<br>4. To discuss advanced statistical tools with examples. | | | |
| Course Out comes | 1. Students learnt about Graphs, measures of averages, measures of dispersion etc.<br>2. Students understood about basic probability and important distributions with workout examples.<br>3. Students applied t, F, $\chi^2$, ANOVA and ANCOVA and non-parametric tests and discussed with examples.<br>4. Students used Advanced statistics tools with illustrations. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **1** | **2** | **1** | **2** | **1** | | | **1** | | **2** | **2** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | **3** | **1** | **2** | **1** | **2** | **1** | | | **1** | | **2** | **2** |
| **CO3** | **3** | **1** | **2** | **1** | **2** | **1** | | | **1** | | **2** | **2** |
| **CO4** | **3** | **1** | **2** | **1** | **2** | **1** | | | **1** | | **2** | **2** |

# SEMESTER – IV

## ST 401: TIME SERIES ANALYSIS AND FORECASTING METHODS

**Unit-I:** Review of Time Series Analysis. Growth models: Modified Exponential Curve, Gompertz curve, Logistic curve and their Fitting; Measurement of cyclical component: Harmonic analysis, auto regression series: Markoff and Yule's series, Periodogram and correlogram analysis, measurement of irregular component: variate difference method.

**Unit-II:** Need and uses of forecasting, classification and characteristics of forecasts, forecasting based on regression techniques: simple and multiple linear regression and non-linear regression techniques, moving averages smoothing methods: simple and double, multi average methods; explanatory version time series forecasting, test for trend seasonality.

**Unit-III:** Exponential smoothing methods: trend adjusted exponential smoothing, double and triple exponential smoothing, win ten's method, chow's adaptive control methods, brown's one parameter adaptive method: Box-Jenkins three parameter smoothing, Harrison's Harmonic smoothing methods, tracking signal.

**Unit-IV:** Box-Jenkin's time series methods: 1. Moving average 2. Autoregressive (AR) 3. ARMA and 4. AR integrated MA (ARIMA) models, estimation of ARIMA model parameters, forecasting with ARIMA models, Diagnostic checking of the model: Analysis of residuals, forecasting using transfer function model, concept of Kalmon's Filters.

**References**


1. Thomopouls, N.T (1980): Applied Forecasting Methods. Engle Wood Cliffs, N.J, Prentice Hall.
2. Wheel Wishart, S.C; and S. Makridaks (1980): Forecasting Methods for Management III edition, New York. John Wiley.
3. Sullivan, William G. and Wayne Claycambe. W (1977): Fundamentals of Forecasting. Prentice Hall. Virginia.

4. Gupta. S.C and V.K. Kapoor (1995): Fundamentals of Applied Statistics, Sulthan & Chand Sons. New Delhi.
5. Bovas, Abraham and Johannes Ledolter (1983): Statistical Methods for Forecasting, John Wiley & Sons. New York.
6. Box, G.E.P and Jenkkins, G.M (1976): Time Series Analysis Forecasting and Control, Holden Day, San Francisco.
7. Anderson, T.W (1971): The Statistical Analysis of Time Series, John Wiley, New York.
8. Markidakis, S Steven C. Wheel Wright and Victor E. Mcgee (1983): Forecasting: Methods and Applications, 2nd Edition, New York, John Wiley & Sons.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST401** | **Time series Analysis and forecasting methods** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To fit growth curves, measurement of cyclical and irregular component with simple examples.<br>2. To discuss Forecasting and their techniques like regression, non-linear regression, exponential smoothing, etc.<br>3. To explain Box Jenkins time series models and their estimation of parameters, fitting and diagnostic checking.<br>4. To learn the forecasting using transfer function model. | | | |
| Course Out comes | 1. Students understood Time series analysis with some important growth models and their fitting<br>2. Students forecasting using regression, non-linear regression techniques, single, double, triple and adoptive exponential smoothing models.<br>3. Students obtained knowledge on AR, MA, ARMA, ARIMA, models fitting, diagnostic checking, etc.<br>4. Check and validate models with its residual analysis and diagnostic checking. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO2** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO3** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO4** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |

M.Sc. DEGREE EXAMINATION — [illegible]

FOURTH SEMESTER

**Branch : Statistics**

**Paper I ST-401 : TIME SERIES ANALYSIS AND FORECASTING METHODS**

*(Under CBCS w.e.f. 2017-2018)*

Time : 3 hours Max. Marks : 80

## SECTION - A

Answer any FOUR question.

All questions carry equal marks. 1784161

(Marks : 4 × 5 = 20)

Define Time series and explain its mathematical models.

Explain fitting of Gompertz curve for a time series.

Write the need and uses of forecasting.

Explain non-linear regression model for forecasting.

Explain Winten's and Chow's adaptive control methods.

Explain Box-Jenkins three parameter exponential smoothing method.

Discuss diagnostic checking of the ARIMA model.

Discuss the concept of Kalmon's filters.

## SECTION - B

Answer ALL question.

Each question carry equal marks.

(Marks : 4 × 15 = 60)

(a) Explain fitting of logistic curve.

Or

(b) Discuss in detail about the different models of time series.

[P.T.O

2020/2/21 13:19

10. (a) Explain simple, double and multi average smoothing methods.

Or

(b) Explain regression technique for forecasting.

11. (a) Explain trend adjusted exponential smoothing.

Or

(b) Explain Box-Jenkin's three parameter smoothing.

12. (a) Explain ARMA and ARIMA models for estimation.

Or

(b) Explain moving average and Autoregressive methods.

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## ST 402: OPERATIONS RESEARCH – II

**Unit-I:** Bellman's principle of optimality, general formulation, computational methods and application of Dynamic programming. Multi-stage decision processes and Dynamic programming. Goal Programming and stochastic programming.

**Unit-I1:** Queuing models-specifications and effectiveness measures.Steady state solutions of M/M/1 and M/M/c models with associated distributions of queue length and waiting time. M/G/1 Queue and Pollazcek Khinchine result. Steady-state solutions of M/Ek/1 and Ek/M/1 queues. Bulk queues.

**Unit-I1I:** Analytical structure of inventory problems; EOQ formula of Harris, its sensitivity analysis and extensions allowing quantity discounts and shortages. Multi-item inventory, subject to constraints.Models with random demand, the static risk model.(s-S) policy for inventory and its derivation in the case of exponential demand; multi-echelon inventory models.Models witlh variable supply and models for perishable items; estimation of EOQ in some simple cases.

**Unit-IV:** Replacement problems; block and age replacement polices; dynamic programming approach for maintenance problems; replacement of items with long life. Group and individual replacement policies.

**References**


1. Hadley G (1964) Non-Linear and Dynamic programming Addison Weslay.
2. Kleinrock L.(1975) Queueing systems vol.1, Theory; John Wiley.
3. Saaty T.L(1961) : Elements of Queueing Theory with Applications.
4. Gross D and Harris. C.M(1974) Fundamentals of queueing theory ; John Wiley.
5. Philips D.T, Ravindran A and Solberg J Operations Research, Principles and Practice.
6. Curchman C.W; Ackoff R.L and Arnoff E.L(1957) introduction to Operations Research; John Wiley
7. Mckinsey J.C.C(1952) Introduction to the theory of games Mc Graw Hill. P.K. Gupta; D.S. Hira Operations Research S.C Hand.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST- 402** | **Operations Research-II** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. Students learnt about Queuing models.<br>2. Students to know about Dynamic programming, Goal programming.<br>3. Students get the concepts of Stochastic programming, inventory control models, replacement problems with some simple examples.<br>4. To learn the EOQ Models and its estimation. | | | |
| Course Out comes | 1. To perform Dynamic programming and their applications and computation procedure with illustration.<br>2. To discuss different Queuing models steady state solutions with examples.<br>3. To explain Inventory models with and without shortages, S-splicy, EOQ estimation with simple examples.<br>4. To understand Replacement problems such as block and age replacement problems, individual and group replacement policies with examples. | | | |

## Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO2** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO3** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |
| **CO4** | **3** | **1** | **1** | **1** | **2** | | | | **2** | | **3** | **3** |

B-248-04-03

M.Sc. DEGREE EXAMINATION — APRIL/MAY 2019

FOURTH SEMESTER

Branch – Statistics

Paper II – ST 402 – OPERATIONS RESEARCH – II

(Under CBCS w.e.f. *2017-2018*)

Time : 3 hours Max. Marks : 80

SECTION – A

Answer any FOUR questions. All questions carry equal marks.

(Marks : $4 \times 5 = 20$)

1. Explain multi-state Decision Processes.
2. Explain Goal programming problem.
3. Discuss (M/G/1) Queue and Pollaczek Khinchine result.
4. Find steady state solutions of (M/M/C) (∞/FIFO) queues.
5. Discuss analytical structure of inventory problems and it uses.
6. Explain EOQ problem when the demand is not uniform and variable supply.
7. Explain the need of replacement policies.
8. Explain Block replacement policy.

SECTION – B

Answer ALL questions. Each question carries equal marks.

(Marks : $4 \times 15 = 60$)

9. (a) Explain Bellman's principles of optimality.

Or

(b) Explain Dynamic programming problem.

[P.T.O.]

10. (a) Determine steady-state solution of (M/M/C) (∞/FIFO) queuing model.

Or

(b) Find steady-state solution of (M/E$_k$/1) queue.

11. (a) Explain multi-item inventory problem.

Or

(b) Explain EOQ problem when the demand is uncertain and random.

12. (a) Explain group replacement problem.

Or

(b) Explain age-replacement policy of an item with long-life.

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**ST 403 (A): ADVANCED ECONOMETRIC MODELS**

**Unit-I:** Generalized linear Model; Aitken's theorem; GLS estimator, Asymptotic distribution of GLS estimator; Analysis of residuals, OLS, BLUEs and Recursive residuals; Sudentized and predicted residuals; Granger's test of causality; nested and non nested statistical models; Cox and J tests.

**Unit-II:** Specificiation error; Consequences; specification bias; Ramsey's RESET test; Lagrange Multiplier test for adding variables; comparing two linear regression models; Dummy variable approach; Stepwise and Piecewise linear regression; Switching Regression Model.

**Unit-III:** Qualitative and limited dependent variable models; the linear probability model; probit model; Logit model and their estimation; concept of limited dependent variables; specification of Tobit model; concepts of censored and Truncated samples; estimation in censored and Truncated Samples.

**Unit-IV:** Sets of linear regression models; specification of the Seemingly Unrelated Regression Equations (SURE) model; OLS and GLS estimation of SURE model; Zellner's Feasible GLS estimator; Seemingly Unrelated Unrestricted Residuals (SUUR) estimator; Seemingly Unrelated Restricted Residuals (SURR) estimator; Reduction of the Zeller's Feasible GLS estimator to the OLS estimator.

**References**


1. Johnston, J (1984): Econometric Methods, III rd edition , MC Graw Hill.
2. Judge, C.G., Griffths, and Hill, R.C. et al (1985): Theory and Practice of Econometrics, John Wiley.
3. Gujarathi, D (1979): Basic Econometrics, Mc Graw hill.
4. Srivastava, V.K and Giles, D.E.A (1987), Seemingly Unrelated Regression Equations Models: Estimation and Inference, Marcel Dekker, Inc
5. Cook. D and Weisberg. S (1982), Residuals and Inference in Regression, Chapman and Hall.


| Subject Code | Subject Name | Credits Allotted | Total |
|---|---|---|---|

| ST403(A) | Advanced Econometric Models | Theory | Practical | 4 |
|---|---|---|---|---|
| | | 4 | ---- | |
| Course Objective | 1. To explain OLS, GLS, BLUE and Recursive residuals with their properties.<br>2. To discuss different regression models and their importance.<br>3. To perform estimation in censored and Truncated Samples.<br>4. To fit sets of linear regression models and their related estimators. | | | |
| Course Out comes | 1. Students understood GLM, SURE, nested and non-nested statistical models.<br>2. Students learnt about specification error, adding, switching models.<br>3. Students performed probit, logit models and their estimation.<br>4. Students can understand the qualitative and limited dependent variable models. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 2 | | | | 1 | | 2 | 3 |
| CO2 | 3 | 2 | 1 | 2 | 2 | | | | 1 | | 2 | 3 |
| CO3 | 3 | 2 | 1 | 2 | 2 | | | | 1 | | 2 | 3 |
| CO4 | 3 | 2 | 1 | 2 | 2 | | | | 1 | | 2 | 3 |

### ST403 (B): TOTAL QUALITY MANAGEMENT AND SIX SIGMA

**Unit I:** Need for TQM, evolution of quality, Definition of quality, TQM philosophy – Contributions of Deming, Juran, Crosby, Taguchi and Ishikawa.

**Unit II:** Vision, Mission, Quality policy and objective, Planning and Organization for quality, Quality policy Deployment, Quality function deployment, Analysis of Quality Costs.

**Unit III:** Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

**Unit IV** : SIX SIGMA AND PDSA: An overview of six sigma methodology, DMAIC,DFSS and lean six sigma; product / process understanding : SIPOC, VSM, FMEA ; The Seven QC

Tools of Quality, New Seven management tools, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

**Reference**


1. Narayana V. and Sreenivasan, N.S.(1996): "Quality Management – Concepts and Tasks", New Age International.

2. Zeiri(1991): "Total Quality Management for Engineers", Wood Head Publishers.

3. Juran J.M and Frank M.Gryna Jr.(1982): "Quality Planning and Analysis", TMH, India.

4. Brain Rethery(1993): ISO 9000, Productivity and Quality Publishing Pvt.Ltd.

5. D.Mills(1993): Quality Auditing, Chapman and Hall.


| Subject code | Subject Name | Credits Alloted | | Total |
|---|---|---|---|---|
| **ST403(B)** | **TOTAL QUALITY MANAGEMENT AND SIX SIGMA** | Theory | Practical | 4 |
| | | 4 | --- | |
| Course Objective | 1. To explain the need of Total Quality Management and its uses.<br>2. To learn the Quality policy management and its planning.<br>3. To know the concept of teamwork, Leadership, Training and performance measurement.<br>4. To have a overview of six sigma limits and Quality control tools. | | | |
| Course Outcome | 1. Students learn the Quality management importance in real life.<br>2. Students directly know the organizing and planning for the Quality development.<br>3. Students can understand the process managment and leadership to empower the teamwork.<br>4. Students know the tools of quality management and their usage. | | | |

# Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **1** | **1** | **2** | **2** | | | | **1** | | **1** | **1** |
| **CO2** | **3** | **1** | **1** | **2** | **2** | | | | **1** | | **1** | **1** |
| **CO3** | **3** | **1** | **1** | **2** | **2** | | | | **1** | | **1** | **1** |
| **CO4** | **3** | **1** | **1** | **2** | **2** | | | | **1** | | **1** | **1** |

**MODEL QUESTION PAPER**

M.Sc., DEGREE EXAMINATION - NOVEMBER/DECEMBER, 2021

FORTH SEMESTER

**Branch : STATISTICS**

ST403 (B): TOTAL QUALITY MANAGEMENT AND SIX SIGMA

(Under NEP 2021 )

Time : 3 Hours Max. Marks:80

SECTION – A

Answer any FOUR questions

All questions carry equal marks

(Marks : 4 x 5 = 20)

1. Explain Tqm And Its Needs.
2. Explain Quality And Its Importance.
3. Describe Analysis Of Quality Costs.
4. Explain About Quality Policy Deployment.
5. Write About Supply Quality Management.
6. Write About Customer Focus.
7. Explain 6 Sigma Methodology
8. Write About 5s.

SECTION – B

Answer any FOUR questions. Each question carries 15 marks. (Marks : 4 x 15 = 60)

9. Write Briefly About Tqm Philopy Of Contributions Of Design.
   (Or)
10. Explain Taguchia And Shikawa Contributions.
11. Explain Quality Planning And Organization For Qualtiy.
    (Or)
12. Write About Analysis Of Quality Costs.
13. Explain Top Management Commitment.
    (Or)
14. Write About Empowerment And Team Work.
15. Explan New Seven Management Tools.
    (Or)
16. Describe Qulaty Cricles.

**ST 404 : PRACTICAL –VII**

At least 20 practicals covering all papers relating to the subject in this semester must be carried out. (75 marks for practical examination + 15 marks for viva-voce + 10 marks for record in the semester)

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST- 404** | **PRACTICAL VII** | Theory | Practical | 4 |
| | | ----- | 4 | |
| Course Objective | 1. To perform different practical problems manually through calculators and computers.<br>2. To solve Practical problems related to semester - IV papers.<br>3. To Predict the future values based on the present data.<br>4. To Know the importance of real life situations in business. | | | |
| Course Out comes | 1. Students solved Numerical problems related to semester –IV theory papers.<br>2. Students can understand how the statistics can play the role in the prediction of the future data.<br>3. Students can do the future predictions by using the existing data.<br>4. Students can do the research on the statistical data. | | | |

## Mapping of course outcomes with the program outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |

**ST 405 : STUDENT PROJECT**
**Data Centre / Institutions / Companies and etc.,**

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 405** | **STUDENT PROJECT** | Theory | Practical | 4 |
| | | Dissertation submission 60 Marks<br>Presentation 30 Marks +Viva-voce 10 Marks | ---- | |
| Course Objective | 1. To collect primary data from industry, institutions, etc.<br>2. To collect secondary data from internet or any records. | | | |

| | |
|---|---|
| | 3. To analyze the collected data and submit a report in the form a dissertation.<br><br>4. To understand the usage of statistical analysis using different Statistical tools. |
| Course Out comes | 1. Students collected data in different ways.<br>2. Students can prepare different questioner for collection of the data.<br>3. Students can learn data entry in particular software, analysis and interpretation.<br>4. Students learn and prepare the details reports on the projects. |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **2** | | | **3** | **2** | **3** | **2** |

### ST 403 (A): STATISTICAL PROCESS AND QUALITY CONTROL

**Unit-I:** Basic concepts of quality, causes of variation, principle of Shewart's control chart, control charts for attributes and variables. Control limits and probability limits. Process monitoring and control, process capability, modified control chart. Capability indices $C_p$, $C_{pk}$, and $C_{pm}$. Concept of Six sigma and its relationship with process capability.

**Unit-II:** The OC and ARL of Shewart's control charts. Control by gauging, Moving Average and Exponentially Weighted Moving Average charts. CUSUM charts using V-mask and decision interval methods. Multivariate control charts – Control Ellipsoid, Hotelling's $T^2$ chart.

**Unit-III:** Acceptance sampling plans for attribute inspection – Type-A and Type-B OC curves. Single, double and sequential sampling plans and their properties. Sampling plans with rectifying inspection-concept of AOQ, AOQL. Design of Single sampling plan with given ATI. Plans for inspection by variables with one-sided and two-sided specifications.

**Unit-IV:** Sampling plans for continuous inspection-construction of Dodge CSP-1, CSP-2 and Multi level plans and their properties. Chain sampling and its applications. Design of Skip lot

sampling plan and its ASN. Sampling plans with inspection error- derivation of AOQ and ATI in presence of errors.

**References**


1. Montgomery D.C (2009), Introduction to Statistical Quality Control, 6/e, John Wiley and Sons, New York.
2. Edward G. Schilling, Dean V. Neubauer, (2009), Acceptance sampling in quality control Second Edition, Taylor & Francis.
3. Mittage, H.J and Rinne, H (1993): Statistical Methods of Quality Assurance, Chapmann Hall, London, UK.
4. Ott. E.R (1975), Process Quality Control, Mc Graw Hill
5. Phadke, M.S (1989), Quality Engineering through Robust Design, Prentice Hall
6. Duncan, A.J (1974), Quality Control and Industrial Statistics, 3rd Ed., New York, Irwin.
7. Philip J. Ross (1989), Taguchi techniques for quality engineering, McGraw Hill


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST - 406** | **STATISTICAL PROCESS AND QUALITY CONTROL** | Theory | Practical | 4 |
| | | 2 | 2 | |
| Course Objective | 1. To understand the basic concepts of control charts for variables and their indices.<br>2. To discuss different control charts like Shewart's moving average, multivariate etc. with their applications.<br>3. To explain different sequential sampling plans and six sigma tool etc. with their properties and applications.<br>4. To ensure clear idea about the real life quality management. | | | |
| Course Out comes | 1. Students understood the basic concepts of control charts for variables and their indices.<br>2. Students performed different control charts like Shewart's moving average, multivariate etc. with their applications.<br>3. Students used different sequential sampling plans and six sigma tool etc. in solving the problems.<br>4. Students have awareness about Total Quality Management. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **3** | **2** | **3** | | | | **2** | | **1** | **2** |
| **CO2** | **3** | **2** | **3** | **2** | **3** | | | | **2** | | **1** | **2** |
| **CO3** | **3** | **2** | **3** | **2** | **3** | | | | **2** | | **1** | **2** |
| **CO4** | **3** | **2** | **3** | **2** | **3** | | | | **2** | | **1** | **2** |

M.Sc. DEGREE EXAMINATION — APRIL/MAY 2019

FOURTH SEMESTER

Branch – Statistics

Paper IV (A) ST-404 — STATISTICAL PROCESS AND QUALITY CONTROL

(Under CBCS w.e.f. 2017-18)

Time : 3 hours Max. Marks : 80

SECTION – A

Answer any FOUR questions. All questions carry equal marks.

(Marks : 4 × 5 = 20)

1. Explain the role of Normal distribution in SQC.

2. What are the types of control limits and explain their uses with examples?

3. Briefly write about MA charts for means.

4. Explain CUSUM chart.

5. Write a short note on single sequential sampling plan.

6. Explain (a) AOQ (b) AOQL.

7. Describe Multilevel plans and their properties.

8. Explain chain sampling and state its applications.

SECTION – B

Answer ALL questions. Each question carry equal marks.

(Marks : 4 × 15 = 60)

9. (a) Derive ARL for $\bar{X}$ – chart with an example.

Or

(b) Explain the concept of six sigma and its relationship with process capability index.

10 (a) What is V – mask? How are the parameter related to each?

Or

(b) Explain about control Ellipsoid chart and Hotelling's $T^2$ – chart.

[P.T.O.]

11. (a) Explain Type – A and Type B OC curves.

Or

(b) Explain plans for inspection by variables with one sided and two sided specifications.

12. (a) Describe the design and operation of a Skiplot – Sampling plan.

Or

(b) Write a short note on continuous sampling plans. Distinguish between continuous sampling plans and acceptance sampling plans.

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## ST 406 (A) BUSINESS ANALYTICS

**UNIT-I:** BUSINESS MATHEMATICS**:** Matrix Algebra: Addition, Multiplication, Transpose and Inverse of Matrices; Determinants, Solution of Linear Equations; Limits of Algebraic functions; Rules for Differentiation; Linear programming problem-Graphical Method; Applications.

**UNIT-II:** BUSINESS ANALYSIS**:** Statistical Measures: Mean, Median and Mode; Standard Deviation and Coefficient of Variation; Correlation and Regression analysis; Linear and Compound growth rates; Measures of Association; concepts of $R^2$ and $\overline{R}^2$.

**UNIT-III:** BUSINESS STATISTICAL INFERENCE**:** Elements of Probability; Concepts of Binomial, Poisson and Normal Distributions; Sampling Techniques: Simple Random Sampling and Stratified Random Sampling; Determination of sample size; Tests of Significance: z, t, $\chi^2$ and F tests, ANOVA Technique.

**UNIT-IV:** BUSINESS INFORMATICS**:** Time series Analysis; Determination of Trend and seasonal components, Basic Forecasting Methods; computer Applications to Business Analysis; Statistical Quality Control: control charts $\overline{X}$,R, p, npand c-charts.

**References:**

1. Azel and Sounderpandian, Complete Business Statistics, TMH.
2. JK Sharma, Business Statistics, Pearson.
3. RS Bhardwaj, Mathematics for Economics and Business, EB.
4. RP Hooda, Statistics for Business and Economics, McMillan.
5. GC Beri, Business Statistics, TMH.
6. Glynn Davis and BrankoPecar, Business Statistics using Excel, Oxford University press, 2010.
7. J.K. Sharma, Fundamentals of Business Statistics, 2nd Edition, Vikas Publication, 2014.
8. SC Gupta, Fundamentals of Statistics, Himalaya Publications, 2013.
9. N.D. Vohra, Business Statistics, Tata McGraw Hill, 2013.
10. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons Publishers, New Delhi.
11. S.C. Gupta and V.K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand & Sons Publishers, New Delhi.
12. R. Pannerselvam, Research Methodology, Published by PHI Learning Private Limited, New Delhi.
13. Donald R Cooper and Pamela S Schnidler, Business Research Methods, Nineth Edition, Tata Mc Graw Hill Publishing Company Limited, New Delhi.

| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 406 - (a)** | **Business Analytics** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To learn basic statistics and their worked out examples.<br>2. To discuss different tests like t, F, $\chi^2$ and Z fro means, proportions, variances, standard deviation etc. with an illustrations.<br>3. To study ANOVA and ANCOVA for one way and two way classification and their importance in analysis.<br>4. To use special statistical tools and multivariate analysis. | | | |
| Course Out comes | 1. Students learnt Graphs, measures of averages, measures of dispersion etc.<br>2. Students studied basic probability and important distributions with workout examples.<br>3. Students used t, F, $\chi^2$ , ANOVA and ANCOVA and non-parametric tests and discussed with examples.<br>4. Students performed advanced statistics tools for solving the problems. | | | |

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## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | **3** | | | | **1** | **1** | **3** | **2** |
| **CO2** | **3** | **3** | **3** | **3** | **3** | | | | **1** | **1** | **3** | **2** |
| **CO3** | **3** | **3** | **3** | **3** | **3** | | | | **1** | **1** | **3** | **2** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | | | | **1** | **1** | **3** | **2** |

### ST406 (B) : SURVIVAL ANALYSIS

**UNIT – I:**Functions of Survival Time – Definition, Relationship of Survival Functions; Nonparametric Methods of Estimating Survival Functions: Product-Limit Estimate of Survival Function – Kaplan-Meier Estimator of Survival Function.

**UNIT – II:**Nonparametric Methods for Comparing Two Survival Distributions – Gehan's Generalized Wilcoxon Test, Cox - Mantel test, Logrank Test, Peto and Peto's Generalized Wilcoxon Test, Cox's F-test and Mantel-Haenszel Test.

**UNIT – III:**Parametric Methods for Comparing Two Survival Distributions: Exponential, Weibull and Gamma distributions only. Nonparametric and Parametric Methods for

Identifications of Prognostic Factor Relating to Survival Time, Cox Proportional Hazard (PH) Model for Survival Data.

**UNIT – IV:**Analytical Estimation Procedures for Survival Distributions: Exponential, Weibull, Log-Normal and Gamma distributions only.Graphical Methods for Survival Distributions Fitting: Probability Plotting, Hazard Plotting Methods, Tests of Goodness-of-Fit, A Regression Method for Fitting Survival Distribution.

**REFERENCES:**


1. Elisa T.Lee (1992): Statistical Methods for Survival Data Analysis, John Wiley Sons.
2. Miller, R.G. (1981): Survival Analysis, New York, John Wiley & Sons, Inc.
3. Cross A.J. and Clark V.A. (1975): Survival Distribution, Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
4. Elandt Johnson, R.C., Johnson N.L. (1999): Survival Models and Data Analysis, New York, John Wiley & Sons, Inc.
5. Collett, D. (1994), Modeling Survival Data in Medical Research, London: Chapman & Hall.
6. Cox, D. R. and Oakes, D. (1984), Analysis of Survival Data, London: Chapman & Hall.
7. Lawless, J. F. (1982), Survival Models and Methods for Lifetime Data, New York: John Wiley & Sons, Inc.


| Subject Code | Subject Name | Credits Allotted | | Total |
|---|---|---|---|---|
| **ST 406 (b)** | **Survival analysis** | Theory | Practical | 4 |
| | | 4 | ---- | |
| Course Objective | 1. To learn Survival functions and their estimation models.<br>2. To discuss Distributions relating to survival analysis.<br>3. To know the Parametric and Non-Parametric methods of survival time.<br>4. To understand the terms like hazaed function and its applications. | | | |
| Course Out comes | 1. Students learnt about survival functions, their estimating methods, Distributions and their comparison for survival distributions.<br>2. Understand the elements of reliability, hazard function and its applications.<br>3. Understand the concept of censoring, life distributions and ageing classes.<br>4. Estimate nonparametric survival function of the data. | | | |

## Mapping of course outcomes with the program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **1** | **1** | | | | | **1** | | **2** | **2** |
| **CO2** | **3** | **3** | **1** | **1** | | | | | **1** | | **2** | **2** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | **3** | **3** | **1** | **1** | | | | | **1** | | **2** | **2** |
| **CO4** | **3** | **3** | **1** | **1** | | | | | **1** | | **2** | **2** |