SRI VENKATESWARA UNIVERSITY:: TIRUPATI

SVU COLLEGE OF SCIENCES

M.Sc., APPLIED STATISTICS

Syllabus for M.Sc. Applied 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., APPLIED 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	APST - 101	Core	Linear Algebra	6	4	20	80	100
2	APST - 102	Core	Probability and Distributions	6	4	20	80	100
3	APST - 103	Generic Elective	a. Sampling Techniques b. Stochastic Process	6	4	20	80	100
4	APST - 104	Core	Practical-I (75 Practical + 25 Record)	6	4	-	-	100
5	APST - 105	Compulsory Foundation **(Related to Subject)**	Statistical Computing	6	4	20	80	100
6	APST - 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	APST - 201	Core	Statistical Inference	6	4	20	80	100
2	APST - 202	Core	Multivariate Analysis	6	4	20	80	100
3	APST - 203	Core	(a) Linear Models and Applied Regression Analysis (b) Applied Demography and Official Statistics	6	4	20	80	100
4	APST - 204	Core	Practical-III (75 Practical + 15 Viva- voce + 10 Record)	6	4	-	-	100
5	APST - 205	Compulsory Foundation **(Related to Subject)**	Experimental Designs and Applications	6	4	20	80	100
6	APST - 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	APST - 301	Core	Applied Econometrics	6	4	20	80	100
2	APST - 302	Core	Applied Operations Research	6	4	20	80	100
3	APST - 303	Core	Practical- V (75 Practical +25 Record)	6	4	-	-	100
4	APST - 304	Generic Elective * **(Related to Subject)**	(a) Computer Programming and Data Analysis (b) Advanced Bio-Statistics (c) Data Mining and Information Security	6	4	20	80	100
5	APST - 305	Core	Practical-VI (75 Practical + 25 Record)	6	4	-	-	100
6	APST - 306	Open Elective **(For other Department)**	(a) Statistics for Biological and Earth Sciences (b) Statistics for Social and Behavioral Sciences	6	4	20	80	100
	Total			**36**	**24**			**600**

*** Among the Generic Electives the student shall choose ONE**

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	APST - 401	Core	Applied Forecasting Methods	6	4	20	80	100
2	APST - 402	Core	Reliability and Survival Analysis	6	4	20	80	100
3	APST - 403	Core	Practical-VII (75 Practical + 15 Viva-voce + 10 Record)	6	4	-	-	100
4	APST - 404	Generic Elective * **(Related to Subject)**	(a) Statistical Quality Control (b) Statistics for Research, industry and Community Development (c) Actuarial Statistics	6	4	20	80	100
5	APST - 405	Core	**Student Project:** Data Centre / Institutions / Companies and etc.,	6	4	-	-	100
6	APST - 406	Open Elective **(For other Department)**	(a) Statistics for Marketing Research (b) Statistical Analysis Using SPSS	6	4	20	80	100
	Total			**36**	**24**			**600**

*** Among the Generic Electives the student shall choose ONE**

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

Student Project : Dissertation - 60 Marks
Viva Voce - 10 Marks
Presentation - 30 Marks
Total - 100Marks

Multidisciplinary Subjects: M.Sc., Mathematics and M.Sc., Computer Science

APST 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
		Theory	Practical	
APST-101	**Linear Algebra**	4	---	4
Course Objective	1. To Prepare Students about algebra of matrices and vector spaces. 2. To explain about roots vectors and linear transformations with an examples. 3. To Prepare the students on the concept of the orthonogonality and quadratic forms. 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. 2. Students learnt about characteristic roots and vectors with numerical examples. They also know theoretical proofs of theorems. 3. Discriminate between diagonalizable and non-diagonalizable matrices; orthogonally diagonalizable symmetric matrices and quadratic forms 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.

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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)

APST 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 χ^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
APST-102	**Probability and Distributions**	Theory	Practical	4
		4	---	
Course Objective	1. To Explain about classes of sets and Probability measures 2. To discuss on random variables and convergence in probability and the important theorems with proofs. 3. To discuss about inequalities on expectations with their derivations and laws of numbers. 4. To explain about different discrete and continuous distributions and their Properties. 5. To learn about derivations and properties of various sampling distributions. 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. 2. Students also know the weak law, strong law and central limit theorem and their importance 3. Students know about different continuous and discrete distributions and their properties. 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 $Y(\alpha)$ $Y(\beta)$.

APST 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
APST-103 (a)	**Sampling Techniques**	Theory	Practical	4
		4	----	
Course Objective	1. Discuss about basic concepts of sampling techniques PPS WR/WOR models. 2. To study about Hurwitz Thompson estimator, PPS scheme. 3. To learn about Ratio and Regression methods and their properties. 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. 2. Students studied non-Sampling errors and different remedies. 3. Implement Cluster sampling, Ratio and Regression estimation in real life problems 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.

APST 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
APST-103 (b)	**Stochastic Process**	Theory	Practical	4
		4	----	
Course Objective	1. To explain stochastic process and their classification according to space and domain. 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. 3. To explain the concept of the Moving Averages and its applications. 4. To teach the concept of the convergence and smoothing properties and Markov process.			
Course Out comes	1. Students understood stochastic processes, Markov chains, Poisson process, Renewal theory, Branching process, etc. 2. Explain Random walk, Gambler ruins problem and apply Poisson process in real life situations. 3. Understand the consequences of the Intermediate value theorem for continuous function. 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.

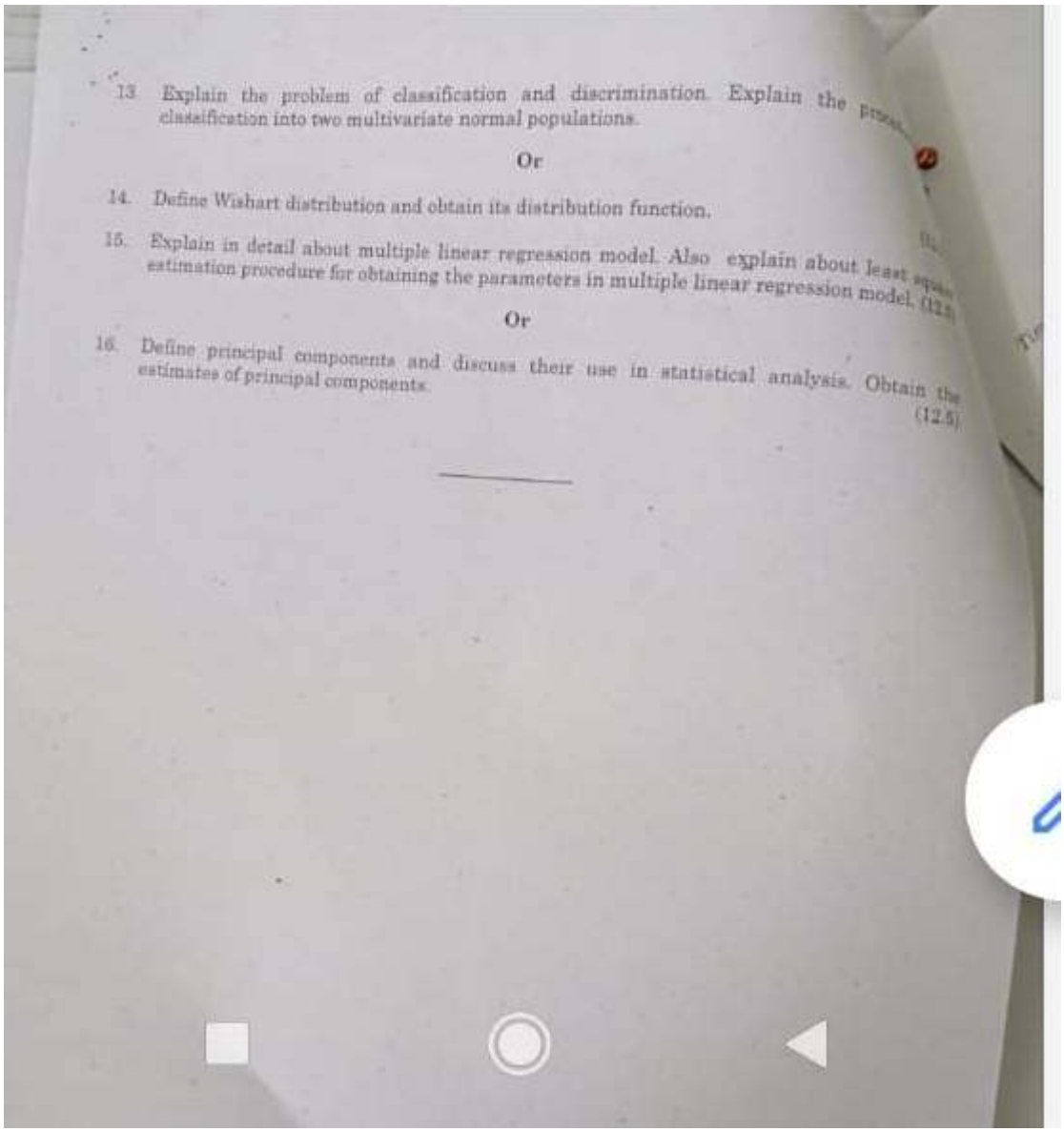
(Marks : 4 × 12.5 marks = 50 marks)

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)

APST 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.

Subject Code	Subject Name	Credits Allotted		Total
APST-103 (b)	**Statistical Analysis Using Excel and SPSS**	Theory	Practical	4
		4	----	
Course Objective	1. To Learn the students about the Statistical functions in Excel. 2. To teach the students the concept of Data Analysis Pak in Excel. 3. To give the introduction of SPSS and its concepts to the students. 4. To teach the students concepts like multiple comparision tests, Regression analysis etc.			
Course Out comes	1. Students can learn how to enter the data MS-Excel. 2. Students can analyze the data in Excel and SPSS. 3. Students can learn how to transfer the data in one data Analysis application to Another. 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.

AP 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**.** 2. Expertise in Object and Classes. 3. To be able to explore Functions and Modules learning. 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. **2.** Students have understood I/O and Error Handling in Python. **3.** Students can understand the looping problems. **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**

APST 105 : PRACTICAL-I

At least 24 practicals covering papers relating to the subjects Linear Algebra, Probability and Distributions 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
APST-105	**PRACTICALS**	Theory	Practical	4
		----	4	
Course Objective	1. To write different problems manually solving through calculators. 2. To write problems and solving them on computers using Statistical software like Excel and other relevant softwares like easy fit etc., 3. To make the students to apply the statistical techniques in the Real life. 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. 2. Linear algebra concepts when working with data preparation, such as one hot encoding and dimensionality reduction. 3. Applying linear algebra problems in real life situations. 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**

APST 106 : PRACTICAL-II

At least 20 practicals covering papers relating to the subjects Linear Algebra, Probability and Distributions 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
APST-106	**PRACTICALS**	Theory	Practical	4
		----	4	
Course Objective	1. To write different problems manually solving through calculators. 2. To write problems and solving them on computers using Statistical software like Excel and other relevant softwares like etc., 3. To teach the students how to use the real life data in computers for analysis. 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. 2. Calculate probabilities relevant to multivariate distributions, including marginal and conditional probabilities and the covariance of two random variables 3. Perform inferential statistical analysis through SPSS. 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

APST 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 τ 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
APST 201	**STATISTICAL INFERENCE**	Theory	Practical	4
		4	----	
Course Objective	1. To study the Estimation methods of point and their different measures and theorems, inequality. 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. 3. To discuss different Non-parametric tests with examples. Asymptotic relative efficiency and truncated distributions. 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. 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. 3. Students may gain the knowledge of testing of hypotheses (both large sample test and small sample test. 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**

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B-248-02-01

M.Sc. DEGREE EXAMINATIONS, OCTOBER -2021

SECOND SEMESTER

Branch : STATISTICS/APPLIED STATISTICS

ST-201 Paper : 1 - 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.

APST 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
5. Srivastava. M.S and Khatri, C.G (1979), An introduction to Multivariate Statistics, North Holland
6. Morrison,F(1985): Multivariate Statistical Methods, Mc Graw Hill Book Company.
7. Johnson A.R and Wishern, D.W (1996), Applied Multivariate Statistical Analysis, Prentice Hall of India
8. Sharma, S (1996), Applied Multivariate Techniques, Wiley
9. Krishisagar, A.M (1972), Multivariate Analysis, Marcel Dekker
10. K.C. Bhuyan(2005): Multivariate Analysis and its Applications, Central

Subject Code	Subject Name	Credits Allotted		Total
APST 202	**Multivariate**	Theory	Practical	4

	analysis	4	----	
Course Objective	1. To study about Multivariate normal distributions and their properties, it's importance. 2. To discuss Hotelling's T^2, Mahalanobis D^2 statistic and its applications and properties. 3. To explain MANOVA with one and two way classified data. 4. To discuss about Principal Component Analysis, Factor Analysis and Cluster Analysis with appropriate methods.			
Course Out comes	1. 1. Students learnt about importance of multivariate variables and their distributions 2. T^2, D^2, MANOVA models are understood and know it's importance. 3. Implement dimension reduction techniques using software on real life problems. 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**

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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?

APST 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
APST 203(a)	**Linear models and Applied Regression Analysis**	Theory	Practical	4
		4	----	
Course Objective	1. To discuss about linear regression models and their assumptions. 2. To study about different criteria for model selection and their Goodness of fit measures. 3. To explain Non normal disturbances and their consequences and statistical analysis of residuals. 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. 2. They know R^2, adjusted R^2 and C_p criteria for model selection. 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**

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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 β 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.

APST 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	
APST-203(B)	**COMPUTER PROGRAMMING – C++**	4	----	4
Course Objective	1. To get a good knowledge of object oriented programming principles. 2. To know about the Friend functions, Inline functions and multiple Inheritance in computer programming. 3. To learn the concpets of the Function overloading and operator overloading. 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++. 2. Students to use the concepts of the multiple inheritance in computer programming. 3. Students to have a clear idea about the overloading. 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.

APST 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, Macmilla
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
APST 204(A)	**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. 3. To discuss on Confounding, their types, confounding 2^n, 3^2 and 3^3 factorial designs etc. 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. 2. Students understood about Latin squares and their construction, missing plot technique etc. 3. Students explained about Incomplete Block Designs and their analysis, etc. 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.]

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.

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.

<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 204</td><td rowspan="2">Industrial Statistics and Quality control</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. Able to understand basics of production process monitoring and apply concept of control charts to it.
2. Apply acceptance and continuous sampling plan in production process.
3. Able to construct sampling inspection plans for attributes and variables.
4. Able to learn some advanced control charts and capability indices.Able to construct Six Sigma limits.</td></tr>
<tr><td>Course Out comes</td><td colspan="4">1. Can identify the cause of defects using statistical quality management techniques.
2. Able to apply statistical quality control techniques to minimize the
3. variability in manufacturing and business process.
4. Acquainted with Six Sigma and lean thinking in industrial experimentation.
5. Expertise in the most import field of applied statistics that contributes to quality control in all most all industries.</td></tr>
</table>

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.

APST 205 : PRACTICAL-III
Paper-1&3

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
APST-205	**PRACTICALS**	Theory	Practical	4
		----	4	
Course Objective	1. To exercise different practical problems manually through calculators. 2. To discuss problems relates to semester - II papers. 3. To Know the real life problems of the Industtrial sector and quality control. 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. 2. Students can solve the theoretical problems in simple way by using c-programming. 3. They can also use the statistical tools and techniques for analyzing the statistical data. 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**	**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**

APST 206 : PRACTICAL-IV
Paper-2&4

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

APST 301: APPLIED ECONOMETRICS

Unit-I: Quick review of inference in classical linear regression model; Estimation and tests of significance of linear and compound growth rates; Incremental analysis; Testing the function form of regression; choosing between linear and log-linear regression models; Likelihood Ratio, Wald and Lagrange Multiplier tests.

Unit-II: Multicollinearity; Sources, consequences and detection of Multicollinearityl Farrar-Glauber test; remedial measures; Heteroscedasticity: Sources and consequences; Tests for Heteroscedasticity; Glejser's test, Goldfield-Quandt test and Breusch-Pagan-Godfrey test; Estimation of parameters under Heteroscedasticity;

Unit-III: Autocorrelation; sources and consequences; first order autoregressive scheme; tests for autocorrelation Durbin-Watson test; Remedies; Estimation of parameters under Autocorrelation; Stochastic Regressors; Errors in variables linear model, IV and ML methods of estimation.

Unit-IV: Finite distributed lag models; Almon's Polynomial approach; Infinite distributed lag models; Geometric lag model; Koyck's approach; IV method; simultaneous linear equations models; Problem of identification; Indirect least squares, LIML, Two stage least squares; three stage least squares and FIML estimation methods.

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
APST-301	**APPLIED ECONOMETRICS**	Theory	Practical	4
		4	----	
Course Objective	1. To study about classical linear regression model and their estimation. 2. To discuss about Autocorrelation, different orders of Autocorrelation and their estimation procedures. 3. To explain different lag models and their estimate procedures. 4. To explain 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. 2. Students understood about different lag models and simultaneous linear equations model with their estimation methods. 3. Explain core concepts and techniques in econometrics, with a special focus on the classical linear regression model.			

	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**

B-240-03-01

M.Sc. DEGREE EXAMINATION — MARCH/APRIL 2021

THIRD SEMESTER

Branch — Applied Statistics

APST-301: Paper I – APPLIED ECONOMETRICS

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

(Regular/Supplementary)

Time : 3 hours Max. Marks : 80

SECTION – A

Answer any FOUR questions. All questions carry equal marks.

(Marks : 4 × 5 = 20)

1. Explain classical linear regression model stating the underlying assumptions. Give two illustrations.

2. Obtain the tests for significance of linear growth rate and compound growth rate.

3. What are the sources and consequences of multicollenearity? Explain.

4. What are the sources and consequences of heteroscadesticity? Explain.

5. Explain Durbin-Watson test for detection of auto-correlation in a regression model and mention the limitations of the test.

6. Discuss the problem of errors in variables in a linear regression model.

7. Discuss the sources of lagged variables. Distinguish between finite distributed lag model and infinite distributed lag model.

8. Explain the simultaneous linear equations model. Give an illustration. Discuss the problem of identification.

[P.T.O.]

SECTION – B

Answer FOUR Questions
Each question carries 15 marks.

(Marks : 4 × 15 = 60)

9. (a) Explain Lagrange multiplier test to examine the specification error of the regression model.

Or

(b) Explain likelihood ratio and Wald tests for examining the functional form of the regression model.

10. (a) Explain Farrar-Glauber test for detection of multicollenearity. List out the remedial measures to overcome the problem of multicollenearity.

Or

(b) Describe Breusch-Pagan-Godfrey test for detection of heteroscadesticity. Explain one estimation method of GLM under heteroscadesticity error terms.

11. (a) What are the sources and consequences of autocorrelation? Explain Cochrane-Orcutt iterative estimation method for estimation of the regression model under autocorrelation.

Or

(b) What does it mean by stochastic regressors? What are the sources? Explain the Instrumental variable estimation method for a MLR model with stochastic regressors.

12. (a) Explain Almon's polynomial approach to a finite distributed lag model and explain Koyak's approach to an infinite distributed lag model.

Or

(b) Derive the two-stage least squares estimator of an over-identified equation in a simultaneous linear equations model.

———————

APST 302: APPLIED OPERATIONS RESEARCH

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-I1: 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. 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.

Unit-IV: 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.

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
APST-302	**APPLIED OPERATIONS RESEARCH**	Theory	Practical	4
		4	----	
Course Objective	1. To explain different queuing models like M/M/I, M/M/C, M/G/I and bulk queues etc. 2. To learn about Non-linear programming and integer programming and their related problems. 3. To discuss about Network flow charts, CPM and PERT, project management models. 4. To study about 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. 2. Students learnt non-linear programming, integer programming, CPM, PERT, different models of games. 3. Students can think the real-life problems in the way of Linear Programming Problems and try to solve the problems in Mathematical Way. 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-240-03-03

M.Sc. DEGREE EXAMINATION — MARCH/APRIL 2021

THIRD SEMESTER

Branch — Applied Statistics

APST – 302 : Paper III — APPLIED OPERATIONS RESEARCH

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

(Regular/Supplementary)

Time : 3 hours Max. Marks : 80

SECTION – A

Answer any FOUR questions. All questions carry equal marks.

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

1. Explain the various approaches used to develop the operations research
2. State the general rules for converting any primal LPP into it's duality.
3. Define non – linear programming problem? With the suitable example.
4. Explain the general quadratic programming problem.
5. Explain the four types of floats used in network analysis.
6. Explain the different between pure strategy and mixed strategy.
7. Show that the average number of units in a $M/M/1$ system is equal to $\rho/(1-\rho)$.
8. Explain Kendall's notations for representing queueing models.

SECTION – B

Answer FOUR questions. Each question carries 15 marks.

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

9. (a) Use dual simplex method to solve.

$$Max\, Z = -2x_1 - x_3$$

$$x_1 + x_2 - x_3 \geq 5,$$

Subject to $x_1 - 2x_2 + 4x_3 \geq 8$ and

$$x_1, x_2, x_3 \geq 0$$

Or

(b) Solve the following problem by revised simplex method

$\min Z = x_1 + 2x_2$ subject to $2x_1 + 5x_2 \geq 6$, $x_1 + x_2 \geq 2$, and $x_1, x_2 \geq 0$.

[P.T.O.]

10. (a) Solve graphically the following Non-Linear Programming Problem(NLPP).

max $Z = 8x_1 - x_1^2 + 8x_2 - x_2^2$, subject to the constraints : $x_1 + x_2 \leq 12, x_1 - x_2 \leq 4$ and $x_1, x_2 \geq 0$.

Or

(b) Apply Wolfe's method to solve the quadratic programming problem.

max $Z x = 2x_1 + x_2 - x_1^2$ subject to $2x_1 + 3x_2 \leq 6, 2x_1 + x_2 \leq 4$ and $x_1, x_2 \geq 0$. Also solve this problem by Beale's method and verify your answer.

11. (a) Construct the network diagram comprising activities B,C....Q and V such that the following constraints are satisfied.

B<E,F;	C>G,L;	E,G<H;
L,H<I;	L<M;	H<N;
H<J;	I,J<P;	P<Q.

Or

(b) Explain the graphysical method of solving $(2 \times n)$ and $(m \times 2)$ games with an example.

12. (a) Explain the concept of imbeded Markov chain. Find the probability generating function (p.g.f) for the number of units in the system (under steady state) for the queueing model $M|G|1|:(\infty|FcFs)$.

Or

(b) For the case of two channels, poisson arrivals and exponential service, show the following:

(i) Probability that both the channels are empty is $(2\mu - \lambda)/(2\mu + \lambda)$.

(ii) Expected number in the system is $4\lambda\mu/(2\mu^2 - \lambda^2)$.

APST 303 : 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 + 15 marks for Viva-voce + 10 marks for record in the semester)

Subject Code	Subject Name	Credits Allotted		Total
APST-303	**PRACTICAL-V**	Theory	Practical	4
		----	4	
Course Objective	1. To perform different practical problems manually through calculators and computers. 2. To solve Practical problems related to semester - III papers. 3. To construct the life tables. 4. To solve the numerical problems relating to Operations Research.			
Course Out comes	1. Students can understand the Statical Methos in Economical Views. 2. Students solved the Numerical problems related to operations research. 3. Students Understand the Life Tables in Demography. 4. Students can understand how the statistics use in biological aspects. .			

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**

APST 304 (A) : ADVANCED BIOSTATISTICS

Unit-I: Structure of Biological assay, Direct assays, Potency ratio, Feller's theorem and its generalization. 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-II:: 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-III: 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.

Unit-IV: Statistical Methods in Clinical Trials- phase I, II, III and IV trails. Statistical design for clinical trials- fixed sample trials. Simple randomized design, stratified randomized design, crossover and sequential designs – open and close sequential design. Dynamic randomization, Permuted block randomization; Single, double and triple blinding methods.

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 Genitics Research Technique, Kalyani Publishers, New Delhi.

7. Elisa T. Lee &John Wenyu Wang (2003): Statistical methods for Survival Data analysis, 3rd Edition, John Wiley
8. Jerrold H. Zar (1999): Biostatistical Analysis, 4th edition, Pearson.
9. Armitage, P, Berry G and Mathews J.N.S. (2002): Statistical Methods in Medical Research, 4/e, Blockwell Scientific Publications.
10. Rastogi. V.B. (2006), Fundamental of Biostatistics. ANE Books, India.

Subject Code	Subject Name	Credits Allotted		Total
APST 304 (A)	**ADVANCED BIOSTATISTICS**	Theory	Practical	4
		4	----	
Course Objective	1. To discuss about Clinical trials and their statistical designs. 2. To know the Dose response relationships, their estimation, transformations. 3. To study 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. 2. Describe single and multi-species population growth models. 3. Apply the concept of deterministic and stochastic models on simple and general epidemics. 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

Fourth SEMESTER

Branch : APPLIED STATISTICS

APST-304 (A) ADVANCED BIOSTATISTICS

(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 Potency Ratio.
2. Describew Qualtal Responces.
3. Describe Alleles.
4. Explaqin Mendal's Law Of Heredity.
5. Write About Gene Pool And Heretregency.
6. Explain Genetic Correlation.
7. Describe Simple Randamized Desighn.
8. Explain Dynamic Randomization.

SECTION – B

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

9. Write About Qualitative Dosc Response Relationship.
   (Or)
10. Explain In Estimation Median Estimative Dose.
11. Describe Phenol Type Ratios.
    (Or)
12. Describe Checker Board Method.
13. Explain Hardy-Weinberg Law Of Equilibrium.
    (Or)
14. Describe Minimum Chi Square Method.
15. Explain Stratified Randomized Design.
    (Or)
16. Explain Triple Blinding Method.

APST 304(B): APPLIED DEMOGRAPHY AND OFFICIAL STATISTICS

Unit-I: Indian and International Statistical Systems, Functions of CSO and NSSO; Organization of large scale sample surveys; Data dissemination systems. Non-Governmental statistical organizations, Methods of conducting population census and Economic census in India. Indian population census.

Unit-II: Official Statistics and their limitations; Methods of collection of official statistics; System of collection of Agricultural Statistics, Crop forecasting and estimation; Agricultural census in India defects; Statistics related to Forests, Fisheries; Trade, Labour, Finance, Price and Industries; CMI, SSMI and ASI publications.

Unit-III: Definition, Scope and limitations of demographic analysis; Sources of Demographic data in India; Mortality measures, Construction of life tables; Abridged life tables; Measures of fertility and Reproduction.

Unit-IV: Methods for population projection, Use of Leslie matrix, Stable and Stationary populations; Lokta's model; Models for population growth and their fitting; Stochastic models for population growth; Concept of Migration and Urbanization, Chandrasekhar nand Demings method, Stochastic model for Birth and Deaths.

References

1. B.N. Gupta (1994), Statistics, Sathiya Bhawan, Agra.
2. B.L. Aggarwal (1994), Basic Statistics, general edition, Wiley eastern, New Delhi.

3. Asthana, B.N.(1970), Indian official Statistics.
4. S. Biswas (1988), Stochastic Process in Demography and Applications, Wiley Eastern, New Delhi.
5. K.B. Pathak and F. Ram (1992), Techniques of Demographic Analysis, Himalayan Publishing House, Bombay.

Subject Code	Subject Name	Credits Allotted		Total
APST 304(b)	**Applied Demography and official statistics**	Theory	Practical	4
		4	----	
Course Objective	1. To study about demography and their importance, different reproduction. 2. To explain population Genetics, CSO, NSSO and their scope and contents in population census in India. 3. To learn the concepts of the population growth models and population estimates. 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. 2. Students understood about gene frequencies, genotypes, phenotypes etc. 3. Students learnt about population census methods, organizations in India and their functions. 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**

AP 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. 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.

UNIT – IV: 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. 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
APST-305	**STATISTICAL ANALYSIS USING R**	Theory	Practical	4
		----	4	
Course Objective	1. Able to create and manipulate vectors, matrices, arrays, data frames and lists. 2. Should be able to work with character data, factor data and			

	dates. 3. Able to write scripts and function in Rand read data from. csvfiles, EXCEL files And SPSS files. 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. 2. Students can work with the character data, factor data and dates. 3. Students get the results using data in R. 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

FOURTH SEMESTER

Branch : APPLIED STATISTICS

APST-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.

APST 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), CurveFitting: 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, χ^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.(1969), Experimental Designs and its appliucations.

Subject Code	Subject Name	Credits Allotted		Total
APST 306 (a)	**Statistics for Biological and Earth sciences**	Theory	Practical	4
		4	----	
Course Objective	1. To learn about basic statistics and their worked out examples. 2. To study Different tests such as t, F, χ^2 and Z fro means, proportions, variances, standard deviation etc. with illustrations. 3. To study ANOVA and ANCOVA for one way and two way classification and their importance in analysis 4. To discuss Special statistical tools and multivariate analysis.			
Course Out comes	1. Students learnt about Graphs, measures of averages, measures of dispersion etc. 2. Students studied Basic probability and important distributions with workout examples. 3. Students performed t, F, χ^2, ANOVA and ANCOVA and non-parametric tests with examples. 4. Students studied 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**	**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**

APST 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, χ^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: LSD. 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 behavioural sciences**	Theory	Practical	4
		4	----	
Course Objective	1. To learn Basic statistics measures with examples 2. To discuss about important concepts, probability distributions like Binomial, Poisson and Normal properties and applications 3. To perform Parametric and non-parametric test with illustrations. 4. To study advanced statistical tools with examples.			
Course Out comes	1. Students learnt Graphs, measures of averages, measures of dispersion etc. 2. Students understood about Basic probability and important distributions and studied with workout examples. 3. Students performed t, F, χ^2, ANOVA and ANCOVA and non-parametric tests and discussed with examples. 4. Students learnt about 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**	**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

APST 401: APPLIED FORECASTING METHODS

Unit-I: 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-II: Exponential smoothing methods: trend adjusted exponential smoothing, double and triple exponential smoothing, winten'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-III: Auto regressive series, yules series, markoff series, deseasonalisting and detrending an observed time series, auto-covariance, Auto Correlation Function(ACF),Partial Auto Correlation Function(PACF) and their properties, conditions for stationary and invertibility. Period gram and correlogram analysis.

Unit-IV: Box-Jenkin's time series methods: Moving average , Autoregressive , ARMA and 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 relation for outline.

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
APST401	**APPLIED FORECASTING METHODS**	Theory	Practical	4
		4	----	
Course Objective	1. To fit growth curves, measurement of cyclical and irregular component with simple examples. 2. To discuss Single, Double, Triple, adoptive exponential smoothing models and its importance. 3. To explain Auto correlation functions and their properties. 4. To discuss about Box Jenkins time series models and their estimation of parameters, fitting and diagnostic checking.			
Course Out comes	1. Students understood Time series analysis with some important growth models and their fitting 2. Students forecasting using regression, non-linear regression techniques, single, double, triple and adoptive exponential smoothing models. 3. Students obtained knowledge on AR, MA, ARMA, ARIMA, models fitting, diagnostic checking, etc. 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	3	1	2	1				1		1	2
CO2	3	3	1	2	1				1		1	2
CO3	3	3	1	2	1				1		1	2
CO4	3	3	1	2	1				1		1	2

B-240-04-01

M.Sc. DEGREE EXAMINATION — APRIL/MAY, 2019

FOURTH SEMESTER

Branch : Applied Statistics

Paper I APST – 401 : APPLIED FORECASTING METHODS

(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. What are the requirements of good forecasting system?
2. Explain explanatory version of time series forecasting.
3. Explain triple exponential smoothing method.
4. Discuss about tracking signal.
5. Explain Markoff series.
6. Explain partial Auto correlation function (PACF) and their properties.
7. Distinguish between Auto regressive and ARMA models.
8. Write in detail about the analysis of residual.

SECTION – B

Answer ALL questions. Each question carries equal marks.

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

UNIT – I

9. (a) Explain classification and characteristics of forecasting.

Or

(b) Explain simple and multiple linear regression and non-linear regression techniques.

UNIT – II

10. (a) Explain exponential smoothing and its properties. Discuss Box–Jenkins three parameter smoothing method.

Or

(b) Explain chow's adaptive control method and brown's one parameter adaptive method.

[P.T.O.]

UNIT - III

11. (a) Explain concepts of deseasonalising and detrending.

Or

(b) Explain periodogram and correlogram analysis.

UNIT - IV

12. (a) Explain ARIMA model for time series data and also obtain various parameters of the given model.

Or

(b) Explain Diagnostic checking of the model and also explain forecasting using transfer function model.

APST 402: RELIABILITY AND SURVIVAL ANALYSIS

Unit-I: Reliability: Concept and Measures of Reliability, bath tub curve, Reliability and failure density in terms of hazard rate; Hazard models, System Reliability Models: Reliability of Series and parallel systems, Mixed configuration models, Non-series-parallel systems; r-out of n- systems, Fault tree analysis.

Unit-II: Reliability improvement methods: Redundancy, element, unit and stand by redundancies; Maintainability and availability; Reliability allocation; Life testing and Reliability estimation; Exponential failure model, Normal, Gamma and weibull distributions and their applications in reliability estimation.

Unit-III: Functions of Survival time: Definitions, Relationships of Survival Functions; Non-parametric Methods of Estimating Survival Functions: Kaplan Meier Product limit Estimate; Non-parametric methods for comparing two survival distributions: Gehan's generalized wilcoxon test, Cox-Mantel test, log rank test, Peto and peto's generalized wilcoxon test, Cox's F test and Mantel-Haenszel test.

Unit-IV: Graphical Methods for survival distributions fitting: Probability plotting, hazard plotting methods, testing of goodness of fit; Analytical Estimation Procedures for Survival distributions: Exponential, Weibull, Lognormal and Gamma Distributions only; Regression method for fitting Survival distributions; Parametric methods for comparing two survival distributions: Exponential, Weibull and Gamma Distributions only; Non-parametric and Parametric methods for identification of Prognostic factor relating survival time

References

1. L.S. Srinath (1998): Reliability Engineering, Applied East west Press PVT Ltd., New Delhi.

2. E. Balaguruswamy (1984): Reliability Engineering, Tata MC Graw Hill publishing company, New Delhi.

3. S.K. Sinha and B.K. Kale (1980): Life Testing and reliability Estimation, Wiley Eastern Ltd, New Delhi.

4. S.K. Sinha (1986): Reliability and Life Testing, Wiley Eastern Ltd, New Delhi.

5. Elisa T.Lee (1992), Statistical methods for survival data analysis, John Wiley sons.

6. Miller, R.G (1981), Survival Analysis, John Wiley

7. Cross A.J and Clark, V.A (1975), Survival distribution, reliability applications in the biomedical sciences, John Wiley and sons.

8. Elandt Johnson, R.E., Johnson, N.L.,(1999), Survival Models and Data Analysis, John Wiley and sons

Subject Code	Subject Name	Credits Allotted		Total
		Theory	Practical	
APST402	**RELIABILITY AND SURVIVAL ANALYSIS**	4	----	4
Course Objective	1. To discuss about reliability and their measures, analysis mixed configuration, series and parallel systems with examples. 2. To explain Redundancy for unit, element and stand by with simple applications. 3. To discuss Distributions for life testing and reliability estimation with their applications. 4. To understand Survival functions, survival distributions and fittings.			
Course Out comes	1. Students learnt about and survival analysis with their related distributions, relationships, non-parametric methods for computing survival analysis. 2. Estimate nonparametric survival function of the data. 3. Explain test of exponentiality against nonparametric classes, two sample problems. 4. Understand the elements of reliability, hazard function and its applications.			

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	1				1		3	2
CO2	3	3	2	1	1				1		3	2
CO3	3	3	2	1	1				1		3	2
CO4	3	3	2	1	1				1		3	2

M.Sc. DEGREE EXAMINATION — APRIL/MAY 2019

FOURTH SEMESTER

Branch : Applied Statistics

Paper III APST-402 : RELIABILITY THEORY AND SURVIVAL ANALYSIS

(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 × 5 = 20)

1. Explain fault tree analysis.
2. Explain Bath tub curve.
3. Define (a) Reliability (b) Maintainability.
4. Define different types of failure models for reliability.
5. Explain
   (a) Log rank test
   (b) Peto and Peto's generalised Wilcoxon test.
6. Explain Non parametric methods of estimating survival functions.
7. Explain analytical estimation procedure for survival functions in case of log normal and Gamma distributions.
8. Explain parametric method for comparing two survival distributions using an exponential failures models.

SECTION - B

Answer ALL questions. Each question carries equal marks.

(Marks : 4 × 15 = 60)

9. (a) Explain parallel – series configuration and determine its reliability.

Or

(b) Explain series configuration and its reliability estimation by using an exponential failure model.

[P.T.O.]

10. (a) State the applications of Normal distribution in reliability estimation.

Or

(b) Explain stand by redundancy for improving reliability.

11. (a) Explain Kaplan Meier product limit for estimating survival functions.

Or

(b) Explain Gehan's generalised Wilcoxon test.

12. (a) Explain non-parametric method for indentification of prognostic factor relating survival time.

Or

(b) Explain regression method for fitting survival distribution in case of Weibull failure model.

APST 403(A) : STATISTICS FOR RESEARCH, INDUSTRY AND COMMUNITYDEVELOPMENT

UNIT- I: Response Surface Designs: First and Second order Response Surface models; Rotatable designs; concept of connected design; outliers and Winsorized t - statistic; Stepwise regression; Specification of Random coefficients Regression model; Specification of variance components model; MINQUE Theory; Non parametric regression, the partially linear regression model.

UNIT-II: Simulation: Scope and limitations; Simulation models; Generation of RandomNumbers; Monte-Carlo simulation; Simulation of Queueing, Inventory Systems; Networks and Job sequencing. Data Envelopment Analysis (DEA): Non parametric approach to productive efficiency; Input, output correspondences for Frontier production function; Mathematical Programming for productive efficiency: Farrell and Timmer approaches with reference to Cobb-Douglas production function.

UNIT-III: Demand Analysis: Laws of Demand and Supply; price and partial elasticities of demand; Pigous method for Time Series and Family Budget data; Engel's curve; Pareto law of Income distribution; Production Functions: Basic concepts; Isoquants; Cobb-Douglas, CES and Translog Production functions and their properties and estimation; Tools for Data Mining.

UNIT-IV: Social Surveys for Community Development: Objects, Types of Social Survey; Steps in social survey; Gallop polls; Prephology, Data collection; Kinds of measurement;

Scaling methods: Thurstone, Likert and Guttman methods; Concepts of Validity and Reliability; Methods of calculating reliability coefficients; Test Reliability; ANOVA for Ranked data: Kruskal-Wallis and Friedman tests; Elements of cluster analysis, Factor analysis., path coefficient analysis and Discriminant analysis.

References

1. Das, M.N. and Giri, N.C. (1979), Design and Analysis for Experiments, Wiley Eastern (P)Ltd., New Delhi.
2. Montgomery, C.D. (1976), Design and Analysis of Experiments, Wiley & Sons, New York.
1. Johnston, J., and Dinardo, J. (1997), Econometric Methods, Fourth Edition, Mc Graw-Hill International Editions, New York.
2. Judge., C.G., et.al (1985), Theory and Practice of Econometrics, John Wiley.
3. Taha, H.A. (1992), Operations Research, An Introduction, Fourth Edition,

Subject Code	Subject Name	Credits Allotted		Total
APST 403(A)	**STATISTICS FOR RESEARCH, INDUSTRY AND COMMUNITYDEVELOPMENT**	Theory	Practical	4
		4	----	
Course Objective	1. To understand Response surface models, stepwise, partially linear and non-parametric regression models with their applications. 2. To discuss Simulation models, demand analysis and their related tools 3. To explain Social server, steps in social server measurements with examples.			
Course Out comes	1. Students have done Simulation models, response surface models, demand analysis, social survey and their related measures. 2. Students can understand the basic of research blooms taxonomy of learning levels. 3. Find the topic from current research in statistics education. 4. Students can apply the tools in design, research and developments.			

Mapping of course outcomes with the program outcomes

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

CO3	**3**	**2**	**3**	**1**	**2**				**1**		**3**	**2**
CO4	**3**	**2**	**3**	**1**	**2**				**1**		**3**	**2**

APST 403 (B): 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
APST403(B)	**Advanced Econometric Models**	Theory	Practical	4
		4	----	
Course Objective	1. To explain OLS, GLS, BLUE and Recursive residuals with their properties. 2. To discuss different regression models and their importance. 3. To perform estimation in censored and Truncated Samples. 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.			

	2. Students learnt about specification error, adding, switching models. 3. Students performed Probit, logit models and their estimation. 4. Students can identify 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**	**3**	**2**	**1**				**1**	**1**	**3**	**3**
CO2	**3**	**2**	**3**	**2**	**1**				**1**	**1**	**3**	**3**
CO3	**3**	**2**	**3**	**2**	**1**				**1**	**1**	**3**	**3**
CO4	**3**	**2**	**3**	**2**	**1**				**1**	**1**	**3**	**3**

APST 404 : PRACTICALS - 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
APST 403	**PRACTICAL –VII**	Theory	Practical	4
		-----	4	
Course Objective	1. To solve different practical problems manually through calculators and computers. 2. To do Practical problems related to semester - VII papers. 3. To Predict the future values based on the present data. 4. To Know the importance of real life situations in business. To analyze the collected data and submit a report in the form a dissertation.			
Course Out comes	1. Students solved Numerical problems related to semester –IV theory papers. 2. Students can understand how the statistics can play the role in the prediction of the future data. 3. Students can do the future predictions by using the existing data. 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**	**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**

APST 405: STUDENT PROJECT

Data Centre / Institutions / Companies and etc.,

Subject Code	Subject Name	Credits Allotted		Total
APST 405	**STUDENT PROJECT**	Theory	Practical	4
		Dissertation submission 75 Marks +Viva-voce 25 Marks	----	
Course Objective	1. To take primary data from industry, institutions, etc. for analysis. 2. To collect data through internet or any records called secondary data for analysis. 3. To analyze the collected data and submit a report in the form a dissertation. 4. To understand the usage of statistical analysis using different Statistical tools.			
Course Out comes	1. Students collected data in different ways. 2. Students can prepare different questioner for collection of the data. 3. Students can learn data entry in particular software, analysis and interpretation. 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**	**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**

APST 405 : STATISTICAL 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. 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.

Unit-IV: Total Quality Management - Quality as a corporate strategy, six magnificent tools of process control, quality planning, costs of quality, analysis of quality costs, Zero Defects programme, quality circles, ISO 9000 and its modifications. Taguchi's contributions to Quality Engineering.

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
1. Phadke, M.S (1989), Quality Engineering through Robust Design, Prentice Hall
2. Duncan, A.J (1974), Quality Control and Industrial Statistics, 3rd Ed., New York, Irwin.
3. Philip J. Ross (1989), Taguchi techniques for quality engineering, McGraw Hill

Subject Code	Subject Name	Credits Allotted		Total
APST 405	**Statistical Quality Control**	Theory	Practical	4
		4	----	
Course Objective	1. To discuss the basic concepts of control charts for variables and their indices. 2. To explain different control charts like Shewart's moving average, multivariate etc. with their applications. 3. To understand different sequential sampling plans and six sigma tool etc. with their properties and applications. 4. To ensure the idea about the real life quality management.			
Course Out comes	1. Students with their knowledge in control charts. 2. Students with their knowledge in Concept of Six sigma and its relationship with process capability. 3. Student have awareness about OC and ARL of Shewart's control charts 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**	**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**

B–240–04–04A

M.Sc. DEGREE EXAMINATION — APRIL/MAY, 2019

FOURTH SEMESTER

Branch : Applied Statistics

Generic Elective

Paper IV (A) APST-404 : STATISTICAL QUALITY CONTROL

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

Time : 3 hours Max. Marks : 80

SECTION - A

Answer any FOUR questions.

Each question carries 5 Marks.

(Marks : 4 × 5 = 20)

1. Explain clearly the role of normal distribution in SQC.
2. When do you use c-chart? What are its limits?
3. Explain OC and ARL of Shewartz's control charts.
4. Explain about exponentially weighted moving averagine chart.
5. Explain acceptance sampling plans for attribute inspection.
6. Write a short note on single sequential sampling plan.
7. Explain quality circles.
8. Explain zero defects program.

SECTION - B

Answer ALL questions.

Each question carries 15 marks.

(Marks : 4 × 15 = 60)

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

Or

(b) What are probability limits? How do they differ from control limits?

P.T.O.

APST 406 (A) : STATISTICS FOR MARKETING RESEARCH

UNIT-I: RESEARCH METHODOLOGY: Types of Research; Hypotheses; Research Design; Collection of Data; Marketing Surveys; Sampling Techniques; Research Tools: Scaling Techniques; Problems in Marketing Research; Case study Method; Preparation of Research Report.

UNIT-II: STATISTICS FOR MARKETING: Statistical Measures: Mean, Median and Mode; Standard Deviation and Coefficient of Variation; Correlation and Regression analysis; Multiple correlation and Regression; Coefficient of Association; Linear and Compound growth rates.

UNIT-III: MARKETING INFERENTIAL TECHNIQUES: Elements of probability; Concepts of Binomial, Poisson and Normal distributions; Tests of Significance: z, t, χ^2 and F tests, ANOVA Technique; Non parametric Tests; Components of Experimental Designs: CRD, RBD and LSD.

UNIT-IV: ADVANCED STATISTICS FOR MARKETING: Basic Time Series and Forecasting Methods; Determination of Trend; Process and Product control; control charts$\bar{X}$,R, p, npand c-charts; Operation Research Techniques: Linear Programming Problem-Graphical Method, concept of PERT, CPM; Concepts of Multivariate Statistical Techniques: Factor Analysis, Discriminant Analysis, Cluster Analysis, Computer Applications to Marketing Research.

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
APST 406(a)	**STATISTICS FOR MARKETING RESEARCH**	Theory	Practical	4
		4	----	
Course Objective	1. To give introduction about Research Design and Statistics for Research. 2. To discuss on different Statistical measures like measures of central tendency, measures of dispersion etc. 3. To explain univariate and multivariate statistical techniques with simple applications. 4. To learn the basic statistics and their worked out examples.			
Course Out comes	1. Students learnt about Research design and how to frame questionnaire etc. 2. Statistics relating to research like univariate test like Z, t, F, ANOVA, CRD, RBD and LSD are done. 3. Multivariate statistical techniques like factor analysis, dissemination analysis and cluster analysis are used. 4. Students can understand how the marketing is happening in the real life.			

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**	**3**	**3**
CO2	**3**	**3**	**2**	**1**	**3**				**1**	**2**	**3**	**3**
CO3	**3**	**3**	**2**	**1**	**3**				**1**	**2**	**3**	**3**
CO4	**3**	**3**	**2**	**1**	**3**				**1**	**2**	**3**	**3**

APST 406(B) : STATISTICAL ANALYSIS USING SPSS

Unit-I: Introduction to SPSS, Different Menu's in SPSS, creating a data file, opening excel files, variables and labels, selecting cases by filtering, recoding of data, merging of files,

Unit-II : 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-III : Analysis tools – frequency tables, descriptive, cross tabulations, chi square tests. Compare-Means, ANOVA, Independent Sample t-test, Paired Sample t-test, One-way ANOVA.

Unit-IV: General Linear Model - Univariate, Multivariate, Repeated Measures. Correlation – Simple and Partial, Multiple Linear Regression-Selection variables into the model-Stepwise Multiple Linear Regression.

References

1. Statistics Made Simple-Do it Yourself on PC by K.V.S. Sarma
2. A Handbook of Statistical Analyses using SPSS-Sabine Landau and Brian S. Everitt
3. SPSS for Beginners -Vijay Gupta

Subject Code	Subject Name	Credits Allotted		Total
APST 406 (b)	**Statistical analysis using SPSS**	Theory	Practical	4
		4	----	
Course Objective	1. To understand SPSS software data entry, import and export of data 2. To use Statistical analysis tools using SPSS 3. To explain Bivariate, Multivariate statistics measures using SPSS 4. To know the General linear model and multiple regression analysis.			

Course Out comes	1. Able to create and manipulate vectors, matrices, arrays, data frames and lists. 2. Should be able to work with character data, factor data and dates. 3. Able to write scripts and function in Rand read data from. .csv files, EXCEL files and SPSS files. 4. Able to use built-in functions to answer questions relating to probability distributions, parametric and non-parametric hypothesis testing, correlation and regression analysis, and one-way and two-way ANOVA

Mapping of course outcomes with the program outcomes

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