VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

AS PER NEP-2020

M.Sc. APPLIED STATISTICS

Effective From: 2023-24

1. **Fee Structure:** As per Grant in Aid course

2. **Eligibility for Admission:**

   A candidate must have passed the Bachelor's Degree examination in Science with English as compulsory subject and Statistics at least as a subsidiary subject with Mathematics.

3. **Passing standard** in this course will be same as that of any other science subject.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M. Sc. (Applied Statistics)
Proposed Syllabus as per NEP-2020
Effective from the Academic year 2023-2024

SEMESTER – I

Courses	No.	Title	Hrs/ Week	Exam Schedule			Total Marks	Credit
				Duration (Hrs)	Internal (Hrs)	External Marks		
Core I	101	Basic Mathematics and Element of Probability Theory	4	3	30	70	100	4
Core II	102	Probability Distributions	4	3	30	70	100	4
Core III	103	Operations Research I	4	3	30	70	100	4
Select Any ONE Elective Paper:								
Elective I	1041	Population Studies	4	3	30	70	100	4
Elective II	1042	Sampling Theory-I						
Elective III	1043	Official Statistics						
Practical base on 101 to 104 using Excel and JAMOVI	105	Practical Paper I	12	10-15	50	100	150	6
Skill based Elective Course	106	Statistical Computing with Excel and JAMOVI	2	2	20	30	50	2
		Total	**30**		**190**	**410**	**600**	**24**

SEMESTER – II

Courses	No.	Title	Hrs/ Week	Exam Schedule			Total Marks	Credit
				Duration (Hrs)	Internal (Hrs)	External Marks		
Core-I	201	Statistical Inference-I	4	3	30	70	100	4
Core-II	202	Statistical Inference-II	4	3	30	70	100	4
Core-III	203	Applied Multivariate Analysis	4	3	30	70	100	4
Select any one elective course from 2041 to 2044								
Elective-I	2041	Industrial Statistics	4	3	30	70	100	4
Elective-II	2042	Decision Theory						
Elective-III	2043	Actuarial Statistics						
Elective-IV	2044	Database Management System						
Practical based on 201 to 2044 using excel and jamovi	205	Practical Paper-II	12	10-15	50	100	150	6
Skill based elective course	206	Computer programming language-C	2	2	20	30	50	2
		TOTAL	**30**		190	410	600	24

Core I

Course 101: Basic Mathematics and Element of Probability Theory

Unit I

- Concepts of Function, Algebra of functions, Algebra of functions Polynomial and Exponential functions &Logarithmic functions.
- Concept of Derivative of a function. Derivatives of xn, eX, logx. Algebra of differentiation. Interpretation of derivative as rate of change & Applications.
- Integration as an inverse operation of differentiation. Definite Integral. Integral as the area under a curve. Properties of Integral. Integrals of some standard functions & its Applications.

Unit II

- Sums of some standard series of positive terms.
- **Numerical Methods:** Solution of algebraic and transcendental equations, Numerical integration, Concept of interpolation, Simpson 1/3 rule & 3/8 rule & its Applications.

Unit III

- Determinants, Matrices, Algebra of matrices: Determinants & its properties. Scalar multiplication, addition and multiplication of matrices. Inverse of a square matrix. Concept of rank of a matrix. Rank determination. Linear equations, Systems of linear equations as matrixequations. Characteristic roots and vectors.

Unit IV

- Permutations and Combinations.

  Probability: Sample space of a chance experiment, Elementary outcomes, Events, Representation of events as sets, Combination of events (Complements, Intersections, Unions). Probability functions over a sample space (Discrete case). Case of Equally likely, elementary outcomes: Laplace definition of probability of an event, Axioms of probability. Combinatorial problems of Probability calculation. Conditional Probability. Bayes Theorem. Independent events.

REFERENCES:

1. John Scheick(1997):Linear Algebra With Applications, Mcgraw-hill, ISBN: 10:0071155309, ISBN-13: 9780071155304,
2. Strang(2008):Linear Algebra And Its Applications, Cengage Learning (Thompson), ISBN: 10:8131501728,ISBN-13: 9788131501726
3. Dutta K. B.(2003) : "Matrix and Linear Algebra"; Prentice Hall India, ISBN: 10:8120306368, ISBN-13: 9788120306363
4. Thomas S. Shores(2007): Applied Linear Algebra And Matrix Analysis, Springer Verlag Publication, ISBN:10: 0387331956, ISBN-13:9780387331959,
5. S. Lang, Serge A. Lang (1997): Introduction To Linear Algebra, Springer Publication, ISBN-10: 0387962050, ISBN-13: 9780387962054
6. K.M. Abadir& J.R. Magnus (2005): Matrix Algebra. Cambridge University Press: ISBN-10: 0521822890; ISBN-13: 978-0521822893. [MR2408356]
7. Fuzhen Zhang (1999):Matrix theory: basic results and techniques:, Springer Verlag new York, ISBN: 0387986960

Core II
Course 102: Probability Distributions

Unit I
Random Variables & their Distributions : Definition of random variable, Discrete and continuous random variable. Probability distribution of a random variable. Concept of Probability mass function and Probability density function, Distribution Function (d.f.) of a random variable. **Expectations & Moments of a Distribution :** Expectation of a random variable & a function of a random variable (Discrete and Continuous case). Moments, Different types of moment generating functions, Mean, Variance, Standard deviation, Skewness and Kurtosis of a random variable (distribution). Independence of variables. Linear transformation of variable, Moments under linear transformation, Problems on calculation of mean, variance, S.D. and other moments of a distribution.
Unit II
Frequency Distributions : Frequency distribution of a discrete and continuous random variable (Grouping of data in terms of class intervals). Mean, variance and Moments of a frequency distribution. Bivariate frequency distribution, Conditional distributions and their properties.
Unit III
Some Common Discrete Distributions: (proofs for p.m.f., mean & variance only): Bernoulli distribution, Binomial distribution, Poisson distribution (Quick revision of this three distributions), Hyper-geometric distribution, Negative Binomial distribution, Geometric distribution. General concept of m.g.f. & other important properties of distributions (without proof).
Unit IV
Some Common Continuous Distributions: (proofs for p.d.f., mean & variance only): Uniform distribution, Normal distribution (Quick revision), Exponential distribution, Beta and Gamma distribution. General concept of m.g.f. & other important properties of distributions (without proof) **Sampling Distributions:** Chi-square, t, and F – distribution, Distribution of sample mean and S^2 for Normal distribution (proof for pdf only)

REFERENCES:

1. Mood A. M., Graybill F. A. and Boes D. C. (2001): "An Introduction to Theory of Statistics"; McGraw Hill and Tata McGraw Hill. ISBN: 100070445206, ISBN-13:9780070445208.
2. Goon A. M., Gupta M. K. and Dasgupta B. : "An Outline of Statistical Theory"; Vol. 1 & 2, World press. ISBN:10- 8187567260, ISBN-13: 9788187567264, 978-8187567264
3. Valery Nevzorov, Vicki B. Galloway, V. B. Nevzorov: A Primer On Statistical Distributions ISBN: 10: 0471427985, ISBN-13: 9780471427988.
4. A.k. Md. Ehsanes Saleh Vijay K. Rohatgi(2008): An Introduction To Probability And Statistics, 2nd Ed ISBN: 10- 8126519266, ISBN-13: 9788126519262.
5. Norman L. Johnson, Adrienne W. Kemp, Samuel Kotz(2008):Univariate Discrete Distributions, Set: III-Ed., John Wiley & Sons, ISBN:10: 0470383372, ISBN-13: 9780470383377.
6. Norman L Johnson, Samuel Kotz (2004); Continuous Univariate Distributions,2e, John Wiley, ISBN:10:9812530762, ISBN-13: 9789812530769.
7. Peter Dalgaard (2008): Introductory Statistics with R Statistics and computing, II-Ed., Springer, ISBN: 0387790535, 9780387790534.
8. Julian James Faraway(2006): Extending the linear model with R: generalized linear, mixed effects and nonparametric regression models, CRC Press, ISBN: 158488424X, ISBN-13:9781584884248

Core III
Course 103: Operations Research I

Unit I
Linear Programming Problem (LPP): Basics of LPP with concept and definition (Quick revision), LPP Theorem (without proof), Mathematical Formulation & solution of LPP by Graphical and Simplex Method, Big-M and Two-phase methods, Complications in LPP & their resolution.
Unit II
Duality: Definition of Dual Problem, Rules for converting any Primal into its Dual, Properties of Duality (without Proof) & Dual-Simplex Method **Replacement and Maintenance Model:** Types of Replacement Problem, Replacement Policy of Items whose Efficiency Deteriorates with time and money value changes with constant rate during a Period, Replacement of Items that fails completely
Unit III
Transportation Problems (TP): Definition of Transportation Problem TP, LP formulation of the TP, Methods for getting basic feasible solution to TP, Methods for getting optimum solution to TP, Unbalanced TP, Degeneracy in TP, new methods for initial solution of TP as MIN-MAX & MAX-MIN algorithm. **Assignment Problems (AP):** Definition of AP, Mathematical formulation of the assignment problem, Algorithm for solving an AP, Balanced & Unbalanced AP, Solution methods of AP, Travelling Salesman Problem
Unit IV
Inventory Management Systems: Definition, Costs involved in Inventory Problems, Classical EOQ Models without and with shortages, Multi-item Deterministic Models, Probabilistic Inventory Models, Inventory Models with Price Breaks (without proof) **Theory of Games:** Two person zero-sum games, pure strategies & mixed strategies, Rules of Dominance, Solution Methods of games without Saddle point

REFERENCE:

1. K. Swarup, Gupta P.K. and Man Mohan(2017): "Operations Research"; S. Chand & Co., New Delhi, ISBN: 978-93-5161-101-1
2. G. Hadley (2002): "Linear Programming"; Narosa Book Distributors Pvt Ltd, ISBN: 8185015910, ISBN-13: 9788185015910
3. Murthy K.G.(1988): Linear complementarily, linear and nonlinear programming, Heldermann Verlag, ISBN: 3885384035, 9783885384038
4. Kasana H.S. and Kumar K.D.(2005) : "Introductory Operations Research: Theory & Applications"; Springer Verlag , ISBN: 8181282827, 9798181282827.
5. Kapoor V.K. (2006) : "Operations Research"; 7th Edition, Jain Book Depot, ISBN : 8170148286.
6. Sharma S.D.(2005):Operations Research"; 15th Ed., Kedar Nath Ram Nath & Co. Publishers, Meerut ISBN-13-978-8121902818
7. Hira, D.S., Gupta, P. K.(2007): OPERATIONS RESEARCH, S. Chand & Co., New Delhi, ISBN: 81-219-0281-9

Elective I
Course 1041: Population Studies

Unit I

- **Introduction:**
  The nature of demography, demographic view of population, techniques of population studies. Basic demographic measures, sex-ratio, child-women ratio, cruderates, specific rates.
- **Life Tables :**
  Concepts of Life Tables, Assumptions related to life tables, The columns of life tables, Complete and Abridged life tables, Construction of life tables.

Unit II

- **Mortality :**
  Infant Mortality, Neonatal mortality, Perinatal mortality, Maternal mortality, death rates, standardized death rates.
- **Fertility and Reproduction :**
  Crude Birth Rate (CBR), General fertility rate (GFR), Age specific fertility rate, Total fertility rate (TFR), Gross reproduction rate (GRR), Net reproduction rate (NRR).

  Marriage rates, divorce rates, age pattern of marriage, types of migration, migration rates, migrant components, migrant streams,internal migration, international migration.

Unit III

- **Growth of Population and Models of Population :**
  Introduction, Simple Birth and Death Process, Stationary population models, Stable population models, intrinsic rate of growth, intrinsic age distribution, Quasi stability.
- **Population Estimates and Projections :**
  Inter - censal and Post - censal estimates, population projections, mathematical methods, component methods, mortality basis for projections, fertility basis for projections, migration basis for projections.

Unit IV

- **Census and Sample Surveys :**
  Definition of Census and its features, Organizing the Census, methods of enumeration, Census in India, Indian Census in 1991 and2001.

  Defining the objectives and scope of sample surveys. Questionnaire design, sample design, organization of field work, collecting and processing the data, reporting.

REFERENCES:

1. Barkley G.W. (1958): "Techniques of Population Analysis"; John Wiley & Sons Inc; First Edition, ISBN-10: 0471048186 ,ISBN-13: 978- 0471048183
2. Pathak K. B. and F. Ram (1998) : "Techniques of Demographic Analysis"; 2nd Edition, Himalaya Publishing House, ISBN : 81-7493- 472-3
3. R. Ramakumar (1986): "Technical Demography"; Wiley Eastern Ltd., ISBN: 0852267436
4. H. Raj (1986): "Fundamentals of Demography"; Surjeet Publication.
   ISBN: 8122903363, **ISBN-13:** 9788122903362
5. Cox. P.R. (1970): "Demography"; Cambridge University Press.
6. Keyfitz N. and Caswell H. (2005): "Applied Mathematical Demography"; 3rd Edition, Springer.
7. Keyfitz N. and Beekman J. A.(1984) : "Demography through Problems"; Springer-Verlag, New York, **ISBN10:** 0387908366,**ISBN13:** 9780387908366

Elective II

Course 1042: Sampling Theory I

Unit I

- **The place of sampling in census work:** the sampling process, sampling errors, Development of use of the use of sampling in censuses and surveys, methods of presentation.
- **Requirements of a good sample:** Bias, Methods of selection which give rise to bias, Avoidance of bias in selection, Examples of biased selection, Bias arising due to faulty demarcation of the sampling units, bias in estimation, Circumstances in which bias is permissible, Methods of reducing the random sampling error.
- **Practical Problems arising in the planning, execution and analysis of a survey:** Types of problems, Design of forms, Selection, training and supervision of field investigators, control of accuracy, Methods of handling the data, Questions requiring consideration, determination of the details of the information to be collected, Practicality of obtaining the required information, Methods of collecting the information and dealing with non-response, Frames for censuses, surveys, Agriculture census, undeveloped areas, economic institutions, frames from list of individuals, households, town plans, maps of rural areas, villages etc, Master samples, localized population surveys, market research and opinion surveys, crop estimation, pilot and exploratory surveys, Critical analysis of survey data.

Unit II

- **Non-probabilistic sampling**: Meaning, need, types: convenience, quota, snowball, purposive etc. Advantages and disadvantages.

Unit III

- **Simple random sampling:**
  Simple random sampling with and without replacement, selection of a simple random sample, definitions and notations, properties of the estimates, estimation of population mean, population totals and their standard errors, finite population correction, coefficient of variation of estimator. Confidence Intervals.
- **Sampling proportions and percentages:**
  Qualitative characteristics, Variances of sample estimators, Binomial distribution, Hypergeometric distribution, Confidence limits, classification into more than two classes, proportions and totals over subpopulations.
- **The Estimation of Sample size:**
  Analysis of the problem, The specification of the precision, The formula for n in sampling for proportions and with continuous data, Inverse sampling, sample size with more than one problem, sample size in decision problems, the design effect.

Unit IV

- **Stratified random sampling:** Stratified random sampling, proportional, optimum and Neyman allocation, comparison with simple random sampling for fixed sample size. Stratified sampling for proportions, Covariance and Variance Function. Gain in precision due of stratification. Estimation of sample size with proportions, Effects of deviations from the optimum allocation, effects of errors in the stratum sizes, the problem of allocation with more than one item and its various methods, two-way stratification with small samples, controlled selection, construction of strata, number of strata, post-stratification, estimation of variance with one unit per stratum, estimating totals and means over subpopulations. Sampling from two frames.

REFERENCES:

1. Cochran, W. G. (1977). Sampling Techniques. India: Wiley. ISBN: 9788126515240, 8126515244
2. Madow, W. G., Hansen, M. H., Hurwitz, W. N. (1953). Sample survey methods and theory. United Kingdom: Wiley. ISBN: 9780471006282, 0471006289.
3. Kish, L. (1965). Survey Sampling. United Kingdom: Wiley. ISBN: 9780471489009, 047148900X
4. Murthy M. N. : "Sampling Theory and Methods"; Statistical Publishing Society, Calcutta.
5. Chandhok, P., Raj, D. (2013). Sample Survey Theory. United States: Create Space Independent Publishing Platform. ISBN: 9781481027090, 1481027093
6. Raj, D. (1972). The design of sample surveys. United Kingdom: McGraw-Hill. ISBN: 9780070511552, 0070511551
7. Sukhatme, P. V., Sukhatme, B. V. (1970). Sampling Theory of Surveys: With Applications. India: Asia Publishing House. ISBN: 9780210225196, 021022519X.
8. Yates, F. (1960). Sampling Methods for Censuses and Surveys. United Kingdom: Hafner Publishing Company. ISBN: 9780852640067, 0852640064.
9. Goulden, C. H. (1952). Methods of Statistical Analysis. Japan: Wiley. ISBN: 9780598555977, 0598555978
10. Cochran, W. G., Snecdecor, G. W. (1989). Statistical Methods. India: Wiley. ISBN: 9780813815619, 0813815614
11. Rao, P. S. (2017). Sampling Methodologies with Applications. United Kingdom: CRC Press. ISBN: 9781138462557, 1138462551
12. Chaudhuri, A. (2018). Survey Sampling. United States: CRC Press. ISBN: 9781498774758, 149877475X
13. Som, R. K. (1996). Practical Sampling Techniques, Second Edition. Hong Kong: Taylor & Francis. ISBN: 9780824796761, 0824796764.
14. Foreman, E. (1991). Survey Sampling Principles. Hong Kong: Taylor & Francis. ISBN: 9780824784072, 0824784073.
15. Fowler, F. J. (2014). Survey Research Methods. United Kingdom: SAGE Publications. ISBN: 9781452259000, 1452259003
16. International Encyclopedia of Statistical Science. (2010). Germany: Springer. ISBN: 978-3-642-04897-5
17. Daniel, J. (2011). Sampling Essentials: Practical Guidelines for Making Sampling Choices. Italy: SAGE Publications. ISBN: 9781412952217, 1412952212.

Elective III
Course 1043: Official Statistics

Unit I
• Official statistics: Meaning, Need, Uses, Users, Reliability, Relevance, Limitations, Transparency, its visibility, Compilation, Collection, Processing, Analysis and Dissemination, Agencies Involved, Methods. • Introduction to National and International official statistical system. Role, function and activities of Central and State statistical organisations. Nodal Ministry of India: MOSPI. • National Statistical Organization: Vision and Mission, NSSO and CSO; roles and responsibilities; Important activities, Publications etc. • National Statistical Commission: Need, Constitution, its role, functions etc; Legal Acts/ Provisions/ Support for Official Statistics; Important Acts
Unit II
• Index Numbers: Different Types, Need, Data Collection Mechanism, Periodicity, Agencies Involved, Uses. • Sector Wise Statistics: Agriculture, Health, Education, and prices, Labour, Industry, Women and Child etc. Important Surveys related them, Indicators, principal publications, Agencies and Usages etc.
Unit III
• National Income – Measures of national income - Income, expenditure and production approaches - Applications in various sectors in India. Measurement of income inequality: Lorenz curves, Application of Pareto and Lognormal as income distribution. • National Accounts of India: Definition, Basic Concepts; issues; the Strategy, Collection of Data and Release.
Unit IV
• Population Census: Need, Data Collected, Periodicity, Methods of data collection, dissemination, Agencies involved. • Socio Economic Indicators, Gender Awareness/Statistics, Other Important Surveys and census. Organization of large scale sample surveys. General and special data dissemination systems.

REFERENCES:

1. https://unstats.un.org : Historical Perspective of Official Statistics in India
2. https://www.mospi.gov.in : Official statistical System in India, Reports, publications and surveys, NSO and its divisions, NSC.
3. https://censusindia.gov.in : Population census in India
4. Goon A. M., Gupta M. K., and Dasgupta. B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
5. Mukhopadhyay P. (2011). Applied Statistics, Second Edition, Books & Allied Ltd, India
6. United Nations. "Economic and development statistics" http://www.un.org/esa/progareas/stats
7. Fundamental Principles of Official Statistics http://www.unece.org

Skill based Elective Course
Course 106: Statistical Computing with Excel and JAMOVI

Unit I

1.1 WINDOWS

- 1.1.1. Typing, Editing, Proofing & Reviewing
- 1.1.2. Formatting Text & Paragraphs, Automatic Formatting and Styles
- 1.1.3. Working with Tables, Graphics and Frames
- 1.1.4. Mail Merge

1.2 POWERPOINTPRESENTATION

- 1.2.1 Preparation of Slides, Inserting Elements into Slides
- 1.2.2 Inserting Animation
- 1.2.3 Preparing Slideshows

Unit II

2.1 EXCEL

- 2.1.1. Working & Editing in Worksheets
- 2.1.2. Creating Formats & Links
- 2.1.3. Formatting a Worksheet & Creating Graphic Objects
- 2.1.4. Creating Charts(Graphs), formatting and analyzing data
- 2.1.5. Organizing Data in a List(Data Management)
- 2.1.6. Sharing & Importing Data
- 2.1.7. Printing

Unit III

3. JAMOVI

- 3.1 Introduction to Jamovi
- 3.2 Data management in Jamovi
- 3.3 Functions in Jamovi
- 3.4 One-way ANOVA
- 3.5 Two-way ANOVA
- 3.6 Correlation and linear regression

Unit IV

4.1.Introduction to Internet

- 4.1.1. Internet Protocols: HTTP, FTP,TCP/IP, etc.
- 4.1.2. Internet Utilities: e-mail, chat, searching, etc.

4.2.Web Browsers and Web Server

4.3.HTML

- 4.3.1. Introduction to
- 4.3.2. HTML Tags

References:

1. Dienes:Work6forwindowsquick&easyreference-Mansfield-BPBISBN:8170292972,ISBN-13:9788170292975
2. LaymanHart(1995):WordPerfect6.0ForWindows/bookAndQuickReference,ISBN:0130346535,ISBN-13: 9780130346537
3. Ron Mansfield(1994):Mastering Word 6 for windows- Mansfield – BPB, ISBN: 8170292980,ISBN-13:9788170292982
4. Townsend:MasteringExcel-4ForWindows,-Townsend–BPB,SBN:8170292301,ISBN-13: 9788170292302
5. Learning statistics with Jamovi (2018)-Danielle Navarro and David R. Foxcroft
6. The jamovi quickstart guide-Jonas Rafi

CORE I

201: Statistical Inference-I

Course Content	**UNIT I:** Estimation & Properties of Point estimator: Theoretical finite and infinite population, parameter, parametric space, statistic, estimation of a parameter, Problem of Criterion of selecting a good estimator, Properties of closeness, Unbiasedness, Consistency, Efficiency and Sufficiency. Jointly sufficient statistics, Statement and application of factorization theorem. Minimal sufficient statistics, Complete sufficient statistics, BAN estimator. **UNIT II:** Minimum variance unbiased estimator, Lower bound of variance of an estimator, Statements & application of Cramer- Rao inequality, condition of existence of uniformly minimum variance bound unbiased estimator, difference between MVUE and MVBUE. Uniformly minimum variance unbiased estimator, statement and applications of Rao-Blackwell theorem and Lehnam - scheffe theorem, Location and scale invariance estimator and parameter. Pitman's estimator for location and scale parameter. (theorems without proof) **UNIT III:** Methods of estimation: (i) Method of maximum likelihood, Properties of maximum likelihood estimator, (ii) Method of moments, (iii) Method of scoring, (iv) Method of minimum chi-square, (v) Method of modified minimum chi-square, (vi) Method of least squares. **UNIT IV:** Interval Estimation: Introduction to confidence interval, Definition of confidence interval, Pivotal quantity, Pivotal quantity method.(i) Confidence interval for mean and variance when sampling is done from normal population. (ii) Confidence interval for large samples.
Reference Books	1. Mood A.M., Graybill F.A. and Boes D.C. (2001) : "An Introduction to Theory of Statistics"; McGraw Hill and Tata McGraw Hill, ISBN: 0070445206, ISBN-13: 9780070445208, 978-0070445208 2. Goon A. M., Gupta M. K. and Dasgupta B. (2000) : "An Outline of Statistical Theory" Vol.1, 2; The World Press Private Limited, ISBN: 8187567260 ISBN-13: 9788187567264, 978-8187567264 3. Rohatgi V.K. (1976): "An Introduction to Probability Theory and Mathematical Statistics"; John Wiley& Sons Incorporated, ISBN-10:0471731358,ISBN-13:9780471731351 4. Mukhopadhyay, P. (1996): "Mathematical Statistics"; New Central Book Agency, Calcutta. 5. Mukhopadhyay Parimal (2000): "Topics in Survey Sampling", Springer-verlag, ISBN: 0387951083, ISBN-13:9780387951089, 978-0387951089. 6. Rao C. R. (2001): "Linear Statistical Inference and its Applications"; 2nd Edition, Wiley-Interscience. ISBN-10: 0471218758, ISBN-13: 978-0471218753 7. Casella G. and Berger R. L. (2001): "Statistical Inference"; 2nd Revised edition Duxbury Press. ISBN-10: 0534243126 , ISBN-13: 978-0534243128 8. Zaven A. Karian and Edward J. Dudewicz (2010): "Handbook of Fitting Statistical Distributions with R"; Chapman and Hall/CRC, ISBN: 9781584887119, ISBN10: 1584887117 9. Zaven A. Karian and Edward J. Dudewicz (2000): "Fitting Statistical Distributions: The Generalized Lambda Distribution and Generalized

	Bootstrap Methods"; Chapman and Hall/CRC, ISBN: 9781584880691, ISBN10: 1584880694 10. Mukhopadhyay Nitis (2006) : "Introductory Statistical Inference"; Chapman and Hall/CRC, ISBN: 9781574446135, ISBN10:1574446134

CORE II

202: Statistical Inference-II

Course Content	**UNITI:** • **Testing of Hypotheses:** Concepts of hypothesis, statistical hypothesis, simple and composite hypothesis, Null and Alternative hypothesis. One sided and two-sided hypothesis. Test of hypothesis, critical region or region of rejection, acceptance region. Types of errors. Sizes of the errors, Level of significance, Size of the test, power function of the test, Two-tail and one tail tests. UNIT**II:** • **MP and UMP tests (without proof)** Neyman–Pearson's Lemma & Generalized Neyman–Pearson's Lemma and its applications to find Most Powerful test and UMP tests for families of distributions admitting monotone likelihood ratio, two sided hypotheses • **Parametric tests:** Large sample test for mean, variance, proportion and correlation ,Smallsampletests:χ2,t,F&Z-transformation, ANOVA **UNIT III:** • **Unbiasedness for testing of hypotheses: (Without proof)** Similar test, relationship with UMP unbiased test, UMP similar test and its application for one parameter exponential family, Similarity and completeness, tests with Neyman structure, UMP unbiased tests for multi-parameter exponential families • Likelihood Ratio Test & Test of significance as its particular case **UNITIV:** • **Concept of Invariance in testing of hypotheses:** Maximal invariant test, most powerful invariant test , • Concept of least favorable distribution and its use in testing of hypotheses • **SPRT:** Wald's sequential probability ratio test, its properties and applications
Reference Books	1. Mood A.M., Graybill F.A. and Boes D.C. (2001): "An Introduction to Theory of Statistics"; McGraw Hill and Tata McGraw Hill, **ISBN:**0070445206,**ISBN-13:**9780070445208,978-0070445208 2. Goon A. M., Gupta M. K. and Dasgupta B. (2000) : "An Outline of Statistical Theory" Vol.1, 2; The World Press Private Limited, **ISBN:**8187567260**ISBN-13:**9788187567264,978-8187567264 3. Lehmann. E.L. and Joseph P. Romano (2005): "Testing Statistical Hypothesis";3rdEdition,Springer,ISBN0-387-98864-5. 4. RohatgiV.K.(1976):"AnIntroductiontoProbabilityTheoryandMathematical

	Statistics";JohnWiley&SonsIncorporated,ISBN-10:0471731358,ISBN-13:9780471731351 5. Mukhopadhyay, P. (1996): "Mathematical Statistics"; New Central Book Agency,Calcutta. 6. RaoC.R.(2001):"LinearStatisticalInferenceanditsApplications";2nd Edition, Wiley-Interscience.**ISBN-10:**0471218758,**ISBN-13:**978-0471218753 **7.** WaldA.(2004):"Sequential Analysis"; Dover Pubns, **ISBN:** 0486439127,**ISBN-13:**9780486439129,978-0486439129 8. DavidJ.Sheskin(2007):"HandbookofParametricandNonparametricStatistical Procedures";Chapman&Hall;4th Edition, **ISBN:**9781584888147,**ISBN10:**1584888148

CORE III

203: Applied Multivariate Analysis

Course Content	**UNIT I:** i. Need of multivariate analysis ii. Multinomial distribution and multivariate Normal distribution – its properties (without proof). **UNIT II:** i. Hotelling T^2 distribution (without derivation) & its applications. ii. Comparisons of several multivariate means: multivariable analysis of variances (one way classification) **UNIT III:** i. Partial correlation and multiple correlations and their significance ii. Multiple linear regression model, least square estimation and its inference. **UNIT IV:** i. Concept and application of (i) Factor analysis (ii) Principal Component analysis and (iii) Canonical Correlation analysis. ii. Discrimination and classification: Separation and classification of populations, classification of multivariate populations. Fisher's discriminant function, Classification of several populations. Fisher's method of discriminating among several populations.
Reference Books	1. Anderson T. W. (2003): "An Introduction to Multivariate Statistical Analysis"; 3rd Edition, Wiley-interscience, **ISBN:** 0471360910, **ISBN-13:** 9780471360919 2. Johnson R.A. and Wichern D.W. (2008) : "Applied Multivariate Statistical Analysis"; Pearson Education(4ingapore) Pte. Ltd., **ISBN:** 8131722228, **ISBN-13:** 9788131722220 3. Stephen E. Fienberg, Jobson J. D., Ingram Olkin (1994): "Applied Multivariate Data Analysis: Volume Ii: Categorical and Multivariate Methods"; Springer, ISBN**:** 0387978046, **ISBN-13:** 9780387978048, 978-0387978048 4. Kshirsagar A.M. (1972): Multivariate Analysis. Marcel Dekker, New York. 5. Kent J. T. , J. M. Bibby, K. V. Mardia (1980) : "Multivariate Analysis (probability And Mathematical Statistics)"; Academic Press, **ISBN:** 0124712525, **ISBN-13:** 9780124712522 6. Morrison D.F. (1990): "Multivariate Statistical Methods"; Mcgraw- hill Professional, **ISBN:** 0071008152,**ISBN-13:** 9780071008150, 978-

0071008150
7. Morrison D.F. (2004): "Multivariate Statistical Methods"; Thomson Brooks/cole, ISBN**:** 0534387780, **ISBN-13:** 9780534387785
8. George A. Marcoulides, Scott L. Hershberger and Marcoulide (1997) : "Multivariate Statistical Methods: A First Course"; Lawrence Erlbaum Associates, **ISBN:** 080582572X, **ISBN-13:** 9780805825725
9. Muirhead R.J. (2005): "Aspects of Multivariate Statistical Theory"; Wiley-interscience, ISBN**:** 0471769851, ISBN-13**:** 9780471769859
10. Seber G.A.F. **(**1984**): "**Multivariate Observations"; John Wiley & Sons Inc., ISBN 10: 047188104X , ISBN 13: 9780471881049
11. Gnanadesikan R. (1997): "Methods For Statistical Data Analysis Of Multivariate Observations"; Wiley-interscience, **ISBN:** 0471161195,ISBN-13**:** 9780471161196
12. Srivastava and Khatri (1979): "An Introduction to Multivariate Statistics"; North Holland, New York.
13. Srivastava M.S. (2002): "Methods of Multivariate Statistics"; John Wiley and Sons Inc., New York.
14. Dillon W.R. and Goldstein M. (1984): "Multivariate Analysis: Methods and Applications"; John Wiley and Sons Inc., New York. **ISBN:** 0471083178, **ISBN-13:** 9780471083177
15. Rohatgi V. K., A. K. Md. Ehsanes Saleh (2008): "An Introduction To Probability And Statistics"; 2nd Ed, Wiley, **ISBN:** 8126519266, **ISBN-13:** 9788126519262
16. Wolfgang Hardle, Zdenek Hlavka (2007): "Multivariate Statistics: Exercises And Solutions"; Springer Verlag, **ISBN:** 0387707840, **ISBN-13:** 9780387707846

Elective Paper
Course-2041: Industrial Statistics

Course Content	**Unit – I** • **Introduction of Statistical Quality** • **Introduction, concept of quality and quality control, Process control and product control, variation in quality, theory of runs, specification limits, process limits and modify limits, advantages(uses) of S.Q.C.** **Unit – II** • **Statistical Quality Control techniques to control process** • **Theory of Control charts** i. **Control charts for variables: X-bar,R-chart and sigma chart** ii. **Control charts for attributes: p-chart, np-chart, c-chart and u-chart** iii. **Comparison between for variables and control charts for attributes.** iv. **Cumulative sum chart** • **Statistical Quality Control techniques to control product quality** i. **Principle of acceptance sampling plans.** ii. **Single and double sampling plan for attribute and their OC, AQL,AOQL,ASN,ATI Functions with graphical interpretation, Use and interpretation of Dodge and Romig's sampling inspection plan tables** iii. **Multiple Sampling plan and Sequential sampling plan** iv. **Plan for acceptance sampling by measurement.** **Unit - III** • **Introduction to six sigma** i. **overview of six sigma, lean manufacturing and Total Quality Management(TQM)** ii. **Organizational structure and six sigma training plans- Selection criteria for six -sigma roles and training plans** iii. **Voice of customers(VOC)** iv. **Importance and VOC data collection** v. **criteria to Quality** vi. **Introduction to DMAIC using one case study: Define Phase, Measure Phase, analyze phase, Improve Phase and control phase.** **Unit - IV** • **Reliability** i. **Basic concepts and distributions for product life, failure rate.** ii. **Reliability function for Exponential, Normal, Lognormal, Weibull Gamma Distributions.** iii. **Analysis of complete Data** iv. **Linear analysis and maximum likelihood analysis of censored data for exponential distribution only** v. **System reliability.**
Reference Books	1. Hopper A.G. (1969):"Basic Statistical Quality Control"; McGraw Hill, London. ISBN 100070941092, ISBN 13 9780070941090 2. Gupta R.C. (1998): "Statistical Quality Control"; 10th edition Khanna Publishers, New Delhi. ISBN-13 978-81-7409-111-6 3. Ryan T.P. (2011): "Statistical Methods for Quality Improvement"; John Wiley & Sons. ISBN:9780470590744, ISBN:9781118058114 4. Sinha S.K. (1986): "Reliability and Life Testing"; Wiley Eastern Ltd., New Delhi.

	5. Bazovksy I. (2004): "Reliability Theory and Practice"; Prentice Hall International Series in Engineering. ISBN-10 0486438678, ISBN-13 978-0486438672 6. Grant E. L. and Leavenworth R. (2017): "Statistical Quality Control"; 7th edition Tata Mc Graw Hill Publishing Co. Ltd., New Delhi. ISBN-10 0070435553, ISBN-13 978-0070435551 7. Irving W.B. (2020): "Elementary Statistical Quality Control"; 2ed edition Marcel Dekker, Inc., New York. ISBN-10 0367578123, ISBN-13 978-0367578121 8. Douglas C. Montgomery: (2020) "Introduction to statistical quality control"; 8th edition WileyISBN-10 1119723094, ISBN-13 978-1119723097

Elective paper
Course-2042: Decision Theory

Course Content	**UNIT I:** • **Review of basic elements of statistical decision problem:** Various inference problems viewed as a decision problem. **UNIT II:** • **Introduction to Decision Analysis:** Pay-off table for decisions and discussion of decision criteria (Maximax, Maximin, Minimax, Laplace, Hurwitz, EMV,EOL, EVPI), Decision making under uncertainty and risk, Decision trees. **UNIT III:** • **Main theorems of Decision Theory:** Natural ordering of decision rules. Complete and essentially complete classes of decision rules. Admissibility of Bayes rules. Existence of Bayes decision rules and of Minimax complete class when parameter space is finite and the risk set is closed and bounded from below. **UNIT IV:** • **Invariant decision problems** Invariant decision rules, Admissible, minimax invariant rules.
Reference Books	1. Berger J.O. (1985): "Statistical Decision Theory"; Springer –Verlag Pub. Co., New York. ISBN: 978-1-4419-3074-3 2. Ferguson T.S. (1997): "Mathematical Statistics"; Academic Press. ISBN 0122537505, 9780122537509 3. Kendall M.G. and Stuart A. (1961): "The Advanced Theory of Statistics"; Vol. 2., Ed. IV, Charles and Griffin.ISBN 10: 0470233818ISBN 13: 9780470233818 4. Mood A.M., Grabill F. and Boes D.C. (2017): "Introduction to the Theory of Statistics"; 3rd edition McGraw Hills, International Student Ed. III. ISBN-10 9780070445208, ISBN-13 978-0070445208 5. Rohatgi, V.K. and Saleh, A.K. Md. E. (2005).: "An Introduction to Probability and Statistics", 2ed Edition, John Wiley & Sons. ISBN-109788126519262, ISBN-13 978-8126519262

Elective paper

Course-2043: Actuarial Statistics

Course Content	UNIT I: • **Basics of Probability & Interest**: Theory of Interest, Variable interest rates, continuous time payment streams, Interest rates or discount rates in terms of different time periods. • **Interest & Mortality**: Annuities, Loan Amortization and Mortgage Refinancing, Mortality and Analytical models, Generalized Cash- flow model, discounted cash flow techniques. UNIT II: • **Life Tables**: Concepts of Life Tables, Assumptions related to life tables, columns of life tables, Complete and Abridged life tables, Construction of life tables, Estimation from life table data. • **Finance & financial reporting**: Principal terms in investment and asset management, Key principles of finance, Structure of joint Stock Company and the different methods of financing by which it may be financed, Basic principle of personal and corporate taxation, The characteristics of principal forms of financial instrument used by companies, Factors to be considered by a company when deciding on its capital structure and divided policy UNIT III: • Expected present values of payments, Continuous contracts & residual life, Premium calculations, Repayment of loan by regular instalment of interest and capital, m-payment net single premiums • Population functions and indicator notations, Stationary population concepts UNIT IV: • The investment and risk characteristics of the following types of assets available for investment purposes. • **Risk models**: Proportional Hazard models, excess risk models, Multiple decrement models, death rate estimators, causes specific life insurance premiums.
Reference Books	1. Barcley G.W. (1970): "Techniques of Population Analysis"; John Wiley, New York.ISBN-10 0471048186, ISBN-13 978-0471048183 2. Borowiak, D.S., and A. F. Shapiro. (2013): "Financial and Actuarial Statistics": An Introduction, Second Edition. CRC Press. ISBN-13 978-0367576264 **3.** Donald, D.W.A. (1970): "Compound interest and annuities"; Second Edition, The Institute of Actuaries and the Faculty of Actuaries at the University Press. ISBN-10 1316603873, ISBN-13 978-1316603871 4. Spurgeon, E.T. (2011):"Life Contingencies"; Third Edition, Cambridge University Press. ISBN-10 1107648092, ISBN-13 978-1107648098 5. Eric V. Slud (2001): "Actuarial Mathematics and Life Table Statistics" (Mathematics Department, University of Maryland)

Elective paper

Course:2044

DATA BASE MANAGEMENT SYSTEMS

Course Content	**UNITI:** • Overview of Data base Management System ➢ Introduction to Data base Languages ➢ Advantages of DBMS over file processing systems. • Relational Data base Management System ➢ Entity relationship model ➢ Mapping constraints ➢ Primary Keys ➢ Foreign Keys ➢ Structural Constraints ➢ ER notations & ER model ➢ Enhanced Entity Relationship Model **UNITII:** • Database System ➢ Database Structure ➢ Levels of abstraction in DBMS ➢ View of data ➢ Role of Data base users and administrators ➢ Database Structure: DDL,DML,DCL,TCL **UNITIII:** • Types of Data Models ➢ Hierarchical databases ➢ Network databases ➢ Relational databases ➢ Object oriented databases **UNITIV:** ➢ Stored Procedure ➢ PL/SQL ➢ Concepts Procedure ,Functions, Cursors, Triggers
Reference Books	1. C.J. Date-Narosa (1999): "An Introduction to Database System"; 7th Edition, Pearson. ISBN-10 0201385902 ISBN-13 978-0201385908 2. Henry F.Korth &Abraham Silberschatz & S. Sudarshan (2010): "Data base System Concepts"; 6th edition, McGraw-Hill education. ISBN-10 **0073523321** ISBN-13 **978-0073523323** 3. Jeffrey D. Ullman. (1994): "Principles of Database System"; 3rd edition, Galgotia Pub. ISBN-10 **8175155450**ISBN-13**978-8175155459** 4. Bipin C. Desai. (2010): "Introduction to database system"; revised edition,Galgotiapub.ISBN-10 **8175156171**ISBN-13**978-8175156173** 5. Fundamentals of Database System-Elmasri Nava the, Addison Wesley Elmasri Ramez &Navathe Shamkant. (2017): "Fundamentals of Data base System" 7th edition, **Pearson Education.** ISBN-10 **9789332582705** ISBN-13 **978-9332582705** 6. Navin Prakash. (1991): "Introduction to Databased Management"; **McGraw-Hill Education**ISBN-10 **0074602942**ISBN-13**978-0074602942**TMH 7. Feuerstein & Pribyl. (2005): "Oracle PL/SQL Programming"; O'Reilly, Shroff Publishers & Distributors Pvt. Ltd. ISBN-10 **0596009771**ISBN-13**978-0596009779** 8. Manual of RDBMS

Skill Based Course

Course-206: Computer Programming Language- "C"

Course Content	**Unit-I** **1. Introduction** **1. Algorithms and Flowchart** **2. Types of Languages** **3. Introduction to C Language** **2. C Fundamentals** **1. Identifiers** **2. Data Types** **3. Constants and Variables** **4. Arrays** **3. Operators and Expressions** **1. Arithmetic Operators** **2. Unary Operators** **3. Relations Operators** **4. Logical Operators** **5. Assignment Operators** **6. Conditional Operators** **7. Library Functions** **8. Expressions** **9. Evaluation of Expression** **Unit-II** **1. Data Input and Output** **1. Single Character input and output** **2. The scanf() function** **3. The printf() function** **4. gets() and puts() functions** **2. Control Statements** **1. The While Statement** **2. do-while statement** **3. for statement** **4. if - else statement** **5. switch statement** **6. break statement** **7. continue statement** **8. goto statement** **Unit-III** **1. Arrays** **1. Defining an array** **2. Processing an array element** **3. Multi-dimensional arrays** **4. Passing array to a function** **5. Arrays and Strings** **2. Structures and Unions** **1. Defining a structure** **2. Processing a structure** **3. Unions**

	Unit-IV **1. Functions** **1. Introduction to functions** **2. Function definition** **3. Accessing function** **4. Passing arguments to function** **5. Recursive function** **2. Data Files** **1. Opening a file** **2. Reading and writing operations in file** **3. Closing a file**
Reference Books	1. Karnighan B. W. and Ritchie D. M. (1978):"C programming Language"; Prentice Hall- Gale, ISBN: 0131101633, ISBN-13: 9780131101630 2. Vijay Mukhi: "The C Odyssey -vol. 6: Windows"; Bpb, ISBN:8170291682, ISBN-13: 9788170291688 3. Stephan G. Kochan (2001): "Programming In C"; CBS Publishers &Distributors, ISBN PB: CBS0000031 4. Stephen G. Kochan (2004): "Programming in C"; 3rd Edition, Sams, ISBN-10:0672326663, ISBN-13: 978-0672326660 5. Kelly Stan and Bootle (1988): "Mastering turbo C"; BPB Publications 6. Stan Kelly Bootle (1988): "Mastering Turbo C"; Wiley John & Sons Incorporated, ISBN-13: 9780895884626, ISBN: 0895884623 7. Kanetkar Yashwant (2006): "Let us C"; 9th Edition, BPB, ISBN:8183331637, ISBN-13: 9788183331630, 8. E Balaguruswamy (2011): "Programming in ANSI C" (fifth edition),Tata Mc-graw Hill, ISBN-10: 0-07-068182-1 ISBN-13: 978-0-07-068182-8, 978-0070681828.

Course-205: Practical paper-II

Course Content	Based on theory paper 201 to 2044
Reference Books	Reference book mention in theory paper 201 to 2044

Syllabi

of

M. Sc. (Applied Statistics)

Semester-III

AS PER NEP 2020

To be implemented from the Academic Year 2024-2025.

UNDER THE FACULTY OF SCIENCE

OF VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

COURSES	NO.	TILTE	HRS/WEEK	EXAM SCHEDULE				
				DURATION (HRS)	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDIT
CORE-I	301	STATISTICAL INFERENCE-III	4	3	30	70	100	4
CORE-II	302	APPLIED REGRESSION ANALYSIS	4	3	30	70	100	4
CORE-III	303	SAMPLING THEORY -II	4	3	30	70	100	4
ELECTIVE-I	3041	STATISTICAL SIMULATION	4	3	30	70	100	4
ELECTIVE-II	3042	DATA MINING						
ELECTIVE-III	3043	STOCHASTIC PROCESS						
PRACTICAL BASED ON 301 TO 3044 USING EXCEL, JAMOVI& SPSS	305	PRACTICAL PAPER –III	12	10-15	50	100	150	6
SKILL BASED ELECTIVE COURSE	306	PROGRAMMING LANGUAGE - PYTHON	2	2	20	30	50	2
TOTAL HRS. FOR STUDENS			30		190	410	600	24
TOTAL HRS. FOR THE DEPTT.			26(Fixed for theory paper)+12/batch of practical =26+(12*No. of batches)					

NOTE: EXAM OF "SKILL BASED ELECTIVE COURSE' BE TAKEN ON COMPUTERS

Core-I

Course: 301: Statistical Inference-III

Unit-I

Introduction:

(i) Introduction of Non-Parametric Test, Assumptions and its Applications,

(ii) Difference Between Parametric Tests and Non-Parametric Tests

(iii)Scale of Measurements and Selection Criteria of different Nonparametric Tests.

Unit-II

Quick overview of the following:

- **One population Test**

(i) The Binomial Test

(ii) The Chi-square Test

(iii) Kolmogorov-Smirnov Test

(iv) Run Test

- **Two Population Test**

(i) Rank Sum Test/Mann- Whitney U Test

(ii) McNemar's Test

(iii) Kolmogorov-Smirnov Test

(iv) Wilcoxon Signed rank test

(v) Spearman rank correlation coefficient

- **K Population case:**

Chi square test for K independent sample

Unit-III

- **Two Population Test (For Independent samples)**

(i) The Walsh Test

(ii) Fisher exact probability test

(iii) Median Test

- **Non-parametric correlation and Kendall-Theil-Sen Regression**

Unit-IV

K Population Case :

- **Independent samples:**

(i) Kruskal-Wallis Test

(ii) Kendall's W Test

(iii) Extension of Median Test

(iv) JonkheereTespstra Test

- **<u>Related Samples:</u>**

(i) Cochran's Q Test

(ii) Friendman Test

(iii) Kendall's W Test

- **Post Hoc Tests:**

(i) Dunn Test

(ii) Dunn Control Test

(iii) Steel Dwass Test

(iv) Nemenyi Test

REFERENCES

1) A. F. Siegel, “Robust regression using repeated medians,” Biometrika, vol. 69, no. 1, pp. 242–244, 1982.

View at: Publisher Site | Google Scholar

2) Farooqi, A Comparative Study of Kendall-Theil Sen, Siegel vs Quantile Regression with Outliers, Ph.D. dissertation, Wayne State University, Detroit, Michigan, 2019. https://digitalcommons.wayne.edu/oa_dissertations
3) C. Suwannapinan, T. Suppakorn, and L. Ingsriswang, “Comparison of efficiency of simple linear regression coefficient estimation methods using Theil, quantile, and least squares method as the data in the independent and dependent variables have outliers,” SWU Science Journal, vol. 32, no. 1, pp. 229–240, 2016.
4) Conover,W.J.(1999). Practical Nonparametric Statistics, 3rd edition.
5) David J. Sheskin (2007): “Handbook of Parametric and Nonparametric Statistical Procedures”.
6) David J. Sheskin (2007) : “Handbook of Parametric and Nonparametric Statistical Procedures”; Chapman & Hall; 4th Edition, ISBN: 9781584888147, ISBN 10: 1584888148
7) Efron, B. (1987): ”Better Bootstrap Confidence Intervals (with discussion).” J. Amer. Statist. Assoc. 82 171-200.
8) Erich L. Lehmann (1975) Nonparametric: Statistical Methods Based on Ranks – Holden-Day, Springer.
9) Eubank, R.L. and Speckman P.L. (1993), ”Confidence Bands in Nonparametric Regression.” J. Amer. Statist. Assoc. 88 1287-1301.
10) Farooqi, Ahmad & Thomas, Ronald. (2020). Simulation and comparison of Theil Sen Re-gression, Theil Sen Siegel Regression, and Quantile Regression with outliers.
11) Gibbons, J., D., Chakraborti, S. (2003. 4th Edition). Nonparametric Statistical Inference, CRC Press
12) Granato, GE (2006): Kendall-Theil Robust Line (KTRLine—version 1.0)—A Visual Basic program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables https://pubs.usgs.gov/tm/2006/tm4a7/
13) Hall, P. (1986), ”On the Bootstrap and Confidence Intervals.” Ann. Statist. 14 1431-1452
14) Hall, P. (1988), ”Theoretical Comparison of Bootstrap Confidence Intervals (with discussion).” Biometrika 75 661-671.
15) Hall, P. (1993), ”On Edgeworth Expansion and Bootstrap Confidence Bands in Nonparametric Curve Estimation.” Journal of the Royal Statisitcal Society, SerB 55 291-304.
16) Hardle, W. and Marron, J.S. (1991), ”Bootstrap Simultaneous Error Bars for Nonparametric Regression.” Ann. Statist. 19 778-796.
17) Hollander, M., Wolfe, D. A., and Chicken, E. (2014). Nonparametric Statistical Methods, 3rd Edition. John Wiley & Sons, Inc.
18) Kvam, P. H., Brani Vidakovic, B. (2007) Nonparametric statistics with applications to science and engineering. Wiley
19) Mao, W. and Zhao L.H. (2003), ”Free-Knot Polynomial Splines with Confidence Intervals.” Journal of the Royal Statisitcal Society, SerB 65 901-919.
20) N. Rodratsa, A Comparative Study of Three Linear Regression Model Estimations: Least Squares Method, Parametric and Nonparametric Bootstrap Method, Chulalongkorn University, Dissertation, 2010.
21) O. Idochi, O. Jude, O. C. Amarachi, and B. Uwabunkonye, “Parametric versus nonparametric simple linear regression on data with and without outliers,” International Journal of Innovation Science Mathematics, vol. 4, no. 5, pp. 175–180, 2016.

View at: Google Scholar

22) Peter Sprent, Nigel C. Smeeton (2007): “Applied Nonparametric Statistical Methods”; 4th Edition, Taylor & Francis Ltd, ISBN: 9781584887010, ISBN 10: 158488701X

23) Rice, J. (1984), ”Bandwidth Choice for Nonparametric Kernel Regression.” Ann. Statist. 12 1215-1230.
24) Sen, P. K. (1968): Estimates of the regression coefficient based on Kendall’s tau
25) Sidney Siegel, N John Castellan, Nonparametric Statistics For Behavioral Sciences. McGraw Hill Kogakusha LTD.
26) Wayne W. Daniel (1990), Applied Nonparametric Statistics. PWS-KENT Publishing Company, Boston
View at: Google Scholar
27) Xia, Y. (1998): ”Bias-Corrected Confidence Bands in Nonparametric Regression.” Journal of the Royal Statistical Society. SerB 60, 797-811.
28) Y. P. Aggarwal (1988), Statistical Methods: Concepts, Application and Computation. Sterling Publishers Pvt. Ltd., New Delhi

Core-II

Course: 302: Applied Regression Analysis

UNIT I:

Introduction:

- Nature of Regression Analysis
- Uses and Interpretation of Regression

Simple Linear Regression

- Ordinary Least Squares Method of Estimation
- The Classical Linear Regression Model
- Properties of Least-Squares Estimators**:** The Gauss–Markov Theorem
- Confidence Intervals and *t*-Tests: The Intercept, Slope, Prediction, Fitted Values
- The Coefficient of Determination, R^2
- The Residuals
- Estimation by Maximum Likelihood.

Unit II:

Multiple Linear Regression (Three variable Regression model)

- The Multiple Linear Regression Model
- Predictors and Regressors
- Ordinary Least Squares and its properties
- Confidence Intervals and *t*-Tests: The Intercept, Slope, Prediction, Fitted Values
- The Coefficient of Determination, R^2 and adjusted R^2
- The Residuals and Residual Analysis
- Estimation of the parameters by Method of Maximum Likelidhood

The general linear model:

- General form of the model: Gauss Markov linear model (GMLM) and Generalised Gauss Markov Linear Model (GGMLM).
- Normal Equations and least squares estimates
- The coefficient of Determination, Normality assumption about error term, Statistical Inference under normality assumption.
- Estimation of the parameters by Method of Maximum Likelihood

UNIT III:

Model Adequacy Checking:

- Introduction
- Residual Analysis
- Detection and treatment of Outliers
- Lack of fit of the Regression Model

Quadratic forms:

- Introduction and distribution of Quadratic forms
- Estimation of scale parameter in the general linear model by quadratic functions.

UNIT IV:

Testing and Analysis of Variance

- General Form for Hypothesis Testing
- Special Cases of the General Form
- General Likelihood Ratio Tests

UNIT-V:

Binomial and Poisson Regression

- Distributions for Counted Data : Bernoulli Distribution, Binomial Distribution, Negative Binomial distribution and Poisson Distribution.
- Regression Models for Counts:
  - Binomial Regression
  - Poisson Regression
  - Negative Binomial Distribution

REFERENCES

1. Rao, C. R. (2009). Linear Statistical Inference and Its Applications. Wiley. 3rd edition. ISBN: 9780471708223
2. Searle, S. R., & Gruber, M. H. J. (2017). *Linear models*. Wiley. 7th edition. ISBN: 9781118952849, 9781118952832
3. Montgomery, D. C., Peck, E. A., Vining, G. G. (2015). Introduction to Linear Regression Analysis. Wiley. 3rd edition. ISBN: 9781119180173, 1119180171
4. Seber, G. A. F. (1977). Linear regression analysis. Wiley. 2nd edition. ISBN: 9780471019671, 0471019674
5. Graybill, Franklin A. (1961). An Introduction to Linear Statistical Models. McGraw-Hill. ISBN: 9780070243316, 007024331X
6. Kshirsagar A. M. (1983). A Course in Linear Models. M. Dekker.ISBN: 9780824715854, 0824715853
7. Weisberg, S. (2013). Applied Linear Regression. Wiley. 5th edition. ISBN: 9781119580140
8. Gujarati, D. N. (2003). Basic Econometrics. McGraw Hill. 5th edition. ISBN: 9780071276252
9. Chatterjee, S., Hadi, A. S. (2006). Regression Analysis by Example. Wiley. 5th edition. ISBN: 9780470055458, 0470055456

Core-III

Course 303: Sampling Theory -II

UNIT I:

- **Methods of estimation in sampling:**

  Ratio method of estimation -Ratio estimator, unbiased ratio estimator and almost unbiased ratio estimator, Product method of estimation, Regression method of estimation, Difference estimator

- **Systematic Random Sampling: -**

  Introduction, Sample Selection Procedures, Advantages and Disadvantages, Estimation of mean, total and proportion. Sampling Variance, Comparison of Systematic with Simple Random Sampling, and Stratified Random Sampling, Interpretation Systematic Sampling, Two-dimensional Systematic Sampling.

UNIT II:

- **Single-Stage Cluster Sampling: Clusters of Equal Sizes**

  Reasons for Cluster Sampling, A Simple Rule, Comparisons of Precision Made from Survey Data, Variance in Terms of Intracluster Correlation, Variance functions, A Cost Function, Cluster Sampling for Proportions

- **Single-Stage Cluster Sampling: Clusters of Unequal Size**

  Cluster Units of Unequal Sizes, Sampling with Probability Proportional to Size, Selection with Unequal Probabilities with Replacement, The Optimum Measure of Size, Relative Accuracies of Three Techniques, Sampling with Unequal Probabilities Without Replacement, The Horvitz-Thompson Estimator, Brewer's Method, Murthy's Method, Methods Related to Systematic Sampling, The Rao, Hartley, Cochran Method, Numerical Comparisons, Stratified and Ratio Estimates

UNIT III:

- **Sub-sampling With Units of Equal Size**

  Two-stage sampling, finding means and variances in two-stage sampling, Variance of the estimated mean in two-stage sampling, sample estimation of the variance, the estimation of proportions , optimum sampling and sub sampling fractions, estimation of m_{opt} from a pilot survey, three-stage sampling.

- **Sub-sampling With Units of Unequal sizes**

  Introduction, sampling methods when n = 1, sampling with probability proportional to estimated size, summary of methods form = 1, sampling methods when n > 1, two useful results, units selected with equal probabilities: unbiased estimator, units selected with equal probabilities: ratio to size estimate, units selected with unequal probabilities with replacement: unbiased estimator, units selected without replacement, comparison of the methods

UNIT IV:

- **Double Sampling**

  Description of the Technique, Double Sampling for Stratification, Optimum Allocation, Estimated Variance in Double Sampling for Stratification, Double Sampling for Analytical Comparisons, Regression Estimators, Optimum Allocation and Comparison with Single Sampling, Estimated Variance in Double Sampling for Regression, Ratio Estimators, Repeated Sampling of the Same Population Sampling on Two Occasions, Sampling on More than Two Occasions, Simplifications and Further Developments.

- **Sources of Error in Surveys**

  Introduction, Effects of Nonresponse, Types of Nonresponses, Call – Backs, A mathematical model of the effects of call backs, Optimum Sampling Fraction Among the Non-respondents, Adjustment for Bias without call backs, A mathematical model for errors of measurement, Effect of constant bias.

REFERENCES

1. Cochran, W.G. (1977). Sampling Techniques. India: Wiley. ISBN:9788126515240,8126515244
2. Madow, W. G., Hansen, M. H., Hurwitz, W.N. (1953). Sample survey methods and theory. United Kingdom: Wiley. ISBN: 9780471006282, 0471006289.
3. Kish, L. (1965). Survey Sampling. United Kingdom: Wiley. ISBN: 9780471489009, 047148900X
4. Murthy M.N.: "Sampling Theory and Methods"; Statistical Publishing Society, Calcutta.
5. Chandhok, P., Raj, D. (2013). Sample Survey Theory. United States: Create Space Independent Publishing Platform. ISBN: 9781481027090, 1481027093
6. Raj, D. (1972). The design of sample surveys. United Kingdom: McGraw-Hill. ISBN: 9780070511552, 0070511551
7. Sukhatme P. V., Sukhatme, B.V. (1970). Samplin g Theory of Surveys: With Applications. India: Asia Publishing House.ISBN:9780210225196, 021022519X.
8. Yates, F. (1960). Sampling Methods for Censuses and Surveys. United Kingdom: Hafner Publishing Company. ISBN: 9780852640067, 0852640064.
9. Goulden, C. H. (1952). Methods of Statistical Analysis. Japan: Wiley. ISBN 9780598555977, 0598555978
10. Cochran, W. G., Snecdecor, G. W. (1989). Statistical Methods. India: Wiley. ISBN: 9780813815619, 0813815614
11. Rao, P. S. (2017). Sampling Methodologies with Applications. United Kingdom: CRC Press. ISBN: 9781138462557, 1138462551
12. Chaudhuri, A. (2018). Survey Sampling. United States: CRC Press. ISBN: 9781498774758, 149877475X
13. Som, R. K. (1996). Practical Sampling Techniques, Second Edition. Hong Kong: Taylor & Francis. ISBN: 9780824796761, 0824796764.
14. Foreman, E. (1991). Survey Sampling Principles. Hong Kong: Taylor & Francis. ISBN: 9780824784072, 0824784073.
15. Fowler, F. J. (2014). Survey Research Methods. United Kingdom: SAGE Publications. ISBN: 9781452259000, 1452259003
16. International Encyclopedia of Statistical Science. (2010). Germany: Springer.ISBN:978-3-642-04897-5
17. Daniel, J. (2011). Sampling Essentials: Practical Guidelines for Making Sampling Choices. Italy: SAGE Publications. ISBN: 9781412952217, 1412952212.

Elective -I

Course 3041: Statistical Simulation

UNIT I:

- Statistic simulations: generating random variables, simulating normal, gamma and beta random variables. Comparison of algorithms to generate random variables. Generating random variables from failure rates.

UNIT II:

- Simulating multivariate distributions, MCMC methods and Gibbs sampler, simulating random fields, simulating stochastic process. Variance reduction technique: importance sampling for integration, control variates and antithetic variables.

UNIT III:

- Simulating a non-homogeneous Poisson process, Optimization using Monte Carlo methods, simulated annealing for optimization. Solving differential equations by Monte Carlo methods.

UNIT IV:

- Jackknife and Bootstrap: Bootstrap methods, re-sampling paradigms, bias and standard errors, Bootstrapping for estimation of sampling distribution. Confidence intervals, variance stabilizing transformation, bootstrapping in regression and sampling from finite populations.

REFERENCES

1. Fishman, G.S. (1996): "Mante Carlo: Concepts, Algorithms and Applications", (Springer), ISBN: 978-0387945279
2. Rubinstein, R.Y. (1981): "Simulation and the Monte Carlo Method" (Wiley), ISBN: 978-0471089175.
3. Ripley, B.D. (1987): "Stochastic Simulations" (Wiley), ISBN: 978-0471917090
4. Ross, S. M. (2002) Simulation (Third Edition) (Academic), ISBN: 978-0125980532.
5. Efron,B. and Tibshirani. R.J. (1993): An introduction to the Bootstrap, ISBN: 978-0412042317.
6. Davison, A.C. and Hinkley,D.V. (1997): Bootstrap methods and their applications (Chapman and Hall), ISBN: 978-0412042317.
7. Sho. J and Tu,D (1995): The Jackknife and the Bootstrap. Springer Verlag, ISBN: 978-0387946030.
8. Farid Aitsahlia (2020): "Monte Carlo Simulation and Finance" , CRC Press , 1st Edition , ISBN : 978-0367435705
9. Sheldon M. Ross (2013): "Simulation" Elsevier, 4th Edition 2006, ISBN : 978-0-12-598063-0.
10. S. Brooks, A. Gelman, G. L. Jones, Xiao-Li Meng (2011): "Handbook of Markov Chain Monte Carlo" , 1st Edition , ISBN : 9781498797863.

Elective –II

Course 3042: Data Mining

UNIT I: Introduction to Data Mining

- Introduction to Data mining
- Types of data mining techniques
- Process of data mining
- Data Pre-processing
- Application of data mining
- Exploratory data analysis (EDA)

UNIT II: Supervised Learning

- Introduction to Classification
- Multiple Linear Regression/Stepwise Regression
- Logistic Regression
- K-nearest neighbours (KNN)
- Bayes classifier
- Nearest neighbour classifier
- Decision tree algorithms (e.g., ID3, C4.5, CART)
- Ensemble Methods: Tree based algorithm (TBA), Random Forest, Bagging and Boosting techniques, Gradient Boosting Machines

UNIT III: Unsupervised Learning

- Introduction to Clustering
- Clustering procedures
- Association Rules
- Self-organizing map

UNIT IV: Optimization

- Neural Network
- Genetic Algorithm

REFERENCES

1. Jiawei Han, Micheline Kamber (2006): "Data Mining"; II-Ed., Morgan Kaufmann Publishers, ISBN: 1558609016, 9781558609013
2. HillolKargupta, Jiawei Han, Philip S. Yu (2008): Next Generation of Data Mining, CRC Press, ISBN: 1420085867, 9781420085860
3. Margaret H. Dunham: "Data Mining - Introductory and Advance Topics"; Pearson Edu., ISBN: 8177587854, 9788177587852
4. The elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, 2nd edition, Springer, 2009.
5. Data Mining: Practical Machine Learning Tools and Techniques, 4th Edition, Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pal, Elsevier (Morgan Kaufmann)
6. Introduction to Data Mining eBook: Global Edition, Pang-Ning Tan, Michael Steinbach, Vipin kumar , Anuj Karpathe, Pearson Eduction, 2019, M03 4, ISBN: 0273775324, 9780273775324
7. Data Mining: The Text Book, Charu C. Aggarwal, Springer

Elective -III

Course 3043: Stochastic Process

UNIT I:

- Stochastic Process, Markov Process and Markov chain.
- Markov chain with finite and countable state space, limiting behaviour of n-step transition probabilities, stationary process.

UNIT II:

- Markov Processes in continuous time (Poisson Process, Birth and death processes), Classification of states of a Markov chain.
- Random walks, Gambler's ruin.

UNIT III:

- Queuing Theory: Definition, Characteristics of a queuing system, Poisson Process and Exponential distribution, Classification of queues, Birth model, Death model, Birth death model.

UNIT IV:

- Detailed study of M/M/1 and M/M/C queuing models.

REFERENCES

1. Karlin S. (1975): "A First Course in Stochastic Processes"; Academic Press, Second Edition, ISBN: 978-0123985521.
2. Hoel P.G., Port S. C. and Stone C. J.: "Introduction to Stochastic Processes"; Houghton Mifflin Co., Bosten, ISBN: 9780395184726.
3. K. Swarup, Gupta P.K. and Man Mohan(2008): "Operations Research"; S. Chand & Co., New Delhi, ISBN: 8180545350, ISBN-13:9788180545351
4. Sharma S.D.(2005): "Operations Research"; Kedar Nath Ram Nath & Co. Publishers, ISBN:13-978-8121902818
5. J. Medhi:" Stochastic Processes" New Age International Publishers, third edition (2009), ISBN: 978-81-224-2664-9
6. R. D. Yates & D. J. Goodman: "Probability and Stochastic Processes" Wiley India PVT. LTD., 2005, ISBN: 978-81-265-3431-9
7. Bhattacharya and Waymir, E.C. (1992): "Stochastic Process with Applications" John Wiley and Sons
8. Sharma J. K. (2013): "Operations Research" 5th Edition, Macmillan Publishers India Ltd. ISBN: 978-9350-59336-3
9. Ivo Adan and Jacques Resing (2002): "Queuing Theory: A Linear Algebraic Approach" Springer, 1st Edition, ISBN: 9780387952638
10. Srinivas R. Chakravarthy (2013): "Stochastic Processes and Queuing Theory" Springer 1st Edition, ISBN: 9781447142629
11. Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris (2019): "Fundamentals of Queuing Theory"** by Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris , Wiley, 5th Edition, ISBN: 9781119493604

Course 305 : Practical Paper –III

Based on Theory Paper 301 to 304

SKILL BASED ELECTIVE COURSE

Course 306: PROGRAMMING LANGUAGE- PYTHON

Unit I

Overview of the Course, Installing Python, Learning Jupyter note book and Spyder, variable types, mathematical and logical operator, conditional statement. If.. Else, For loop, while loop. Data structure in python part1 defining: List, tupple, array, set, dictionary, Lemda function.

Data structure in python part: operations on Inbuilt methods. Installing and understanding various basic libraries viz Numpy, Pandas, statsmodel, matplotlib and seaborn, sklearn. Reading file, writing Files, merging files, sort, index

Unit II

Descriptive statistics and Visualization Data Frequency, Mean, median, Range, Quartile max, min, correlation, percentile. Exploring the data, Summarizing the Data, handling missing value, visualizing the data and interpret summaries for univariate and multi variate data, Scatter plot, Stem and Leaf plot, Line plot, Bar and pie plot, Histogram, Box plot, Heat map.

Unit III

Inferential Statistical Analysis in python-ANOVA, Correlation, Construction of confidence Interval, Parametric Test and Non parametric test.

Unit IV Multivariate techniques- Principal component analysis, Factor analysis, MANOVA and Statistical Modelling- Time series, Linear Regression, Logistic regression and Non-linear regression techniques.

REFERENCES

1. Matthes, E. (2019). **Python Crash Course: A Hands-On, Project-Based Introduction to Programming.** No Starch Press. 2nd edition. ISBN: 9781593279288
2. Sweigart, A. (2015). **Automate the Boring Stuff with Python: Practical Programming for Total Beginners.** No Starch Press. ISBN: 9781593275990
3. Zelle, J. M. (2004). **Python Programming: An Introduction to Computer Science.** Franklin, Beedle & Associates Inc. 2nd edition. ISBN: 9781590282755
4. McKinney, W. (2017). **Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython.** O'Reilly Media. 2nd edition. ISBN: 9781491957660
5. Ramalho, L. (2015). **Fluent Python: Clear, Concise, and Effective Programming.** O'Reilly Media. ISBN: 9781491946008
6. Lutz, M. (2013). **Learning Python.** O'Reilly Media. 5th edition. ISBN: 9781449355739
7. Slatkin, B. (2019). **Effective Python: 90 Specific Ways to Write Better Python.** Addison-Wesley Professional. 2nd edition. ISBN: 9780134853987

SYLLABI
OF
M. Sc. (APPPLIED STATISTICS)
SEMESTER-IV
AS PER NEP 2020
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2024-2025.
UNDER THE FACULTY OF SCIENCE
OF
VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

COURSES	**NO.**	**TILTE**	**HRS/ WEEK**	**EXAM SCHEDULE**				
				DURATION (HRS)	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CRE DIT
CORE-I	401	OPERATIONS RESEARCH II	4	3	30	70	100	4
CORE-II	402	APPLIED DESIGN OF EXPERIMENTS	4	3	30	70	100	4
CORE-III	403	ECONOMETRICS	4	3	30	70	100	4
SELECT ANY ONE ELECTIVE COURSE FROM 4041 TO 4043								
ELECTIVE-I	4041	BIOSTATISTICS & CLINICAL RESEARCH	4	3	30	70	100	4
ELECTIVE-II	4042	ECONOMICS & BUSINESS STATISTICS						
ELECTIVE-III	4043	PROJECT/ DISSERTATION						
PRACTICAL BASED ON 401 TO 4043 USING EXCEL, JAMOVI & R	405	PRACTICAL PAPER-IV	12	10-15	50	100	150	6
SKILL BASED ELECTIVE COURSE	406	PROGRAMMING LANGUAGE "R"	2	2	20	30	50	2
TOTAL HRS FOR STUDETS			**30**		190	410	600	24
TOTAL HRS FOR THE DEPTT.			**38**					

Core-I

Course 401: Operations Research II

UNIT I:

- Sensitivity Analysis:
  - Basic concepts
  - Changes in the coefficient of objective function
  - Changes in the components of vector b and of Matrix A
  - Addition / Deletion of variable in the problem
  - Addition / Deletion of constraint in the problem

UNIT II:

- Integer Programming:
- Introduction
- All and mixed integer programming (IPP) problems
- Gomory's al1-IPP algorithm
- The branch and bound technique
- Zero - one programming

UNIT III:

- PERT / CPM:
- Basic concepts
- Construction and Time Calculation of the Network
- Determination of Float and of the Critical Path
- Crashing a Project
- Scheduling a Project
- Resource Analysis and Allocation
- Application of PERT/ CPM

UNIT IV:

- Sequencing
- Definition, Notations and Assumptions
- Solution of sequencing problem.
- Problems with n-jobs and 2-machincs
- Problems with n-jobs and 3-machines
- Problems with 2-jobs and m-machines
- Dynamic Programming
- Introduction
- The recursive Equation Approach
- Characteristics of Dynamic Programming
- Dynamic Programming Algorithm
- Solution of Discrete D.P.P.
- Some APPLICATION
- Solution of L.P.P. By Dynamic Programming

1. K. Swarup, Gupta P.K. and Man Mohan(2008): “Operations Research”; S. Chand & Co., New Delhi, ISBN: 8180545350, ISBN-13: 9788180545351
2. G. Hadley (2002): “Linear Programming”; Narosa Book Distributors Pvt Ltd, ISBN: 8185015910, ISBN-13: 9788185015910
3. Murthy K.G.(1988): Linear complementarity, linear and nonlinear programming, Heldermann Verlag, ISBN: 3885384035, 9783885384038
4. Kasana H.S. and Kumar K.D.(2005) : “Introductory Operations Research: Theory & Applications”; Springer Verlag , ISBN: 8181282827, 9798181282827.

5. Kapoor V.K. (2006) : “Operations Research”; 7th Edition, Jain Book Depot, ISBN: 8170148286.
6. Sharma S.D.(2005): Operations Research”; 15th Ed., Kedar Nath Ram Nath & Co. Publishers, Meerut,
7. Hira, D. S., Gupta,P.K.(2007): OPERATIONS RESEARCH, S. Chand & Co., New Delh, ISBN: 81-219-0281-9
8. Sharma J. K. (2013): “Operations Research” 5th Edition, Macmillan Publishers India Ltd. ISBN: 978-9350-59336-3
9. Rathindra P. Sen (2010): “Operations Research Algorithms and Applications” PHL Learning PVT. LTD., ISBN: 978-81-203-3930-9

Core – II

Course 402: Applied Design of Experiments.

UNIT I:

- Concept and history of Design of experiments.
- The need for Designed experiments.
- Elementary ideas of blocking and randomized block design.
- Elementary idea of treatment structure and Basic principles of Design of experiments.
- Concept of complete and incomplete block designs. Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin square Design (LSD), their analysis with applications. Missing plot technique for RBD, LSD with their applications.

UNIT II:

- Concept of BIBD and its properties
- Types of BIBD.
- Intra block analysis of BIBD.
- Missing plot technique for BIBD.

UNIT III:

- Analysis of Covariance: Analysis of covariance for CRD, RBD and LSD.
- Youden square design, Cross over design and split-plot designs.

UNIT IV:

- Factorial Experiments: Characterization of experiments, factorial experiments, factorial experiments with factors at two levels, grouping for interaction contrasts, confounding, confounding in more than two blocks, experiments with factors at three levels each, analysis of factorial experiments.

REFERENCE

1. Montgomery, D. C. (2006): "Design and Analysis of Experiments"; 5th Ed, Wiley (India), ISBN: 812651048X, ISBN-13: 9788126510481, 978-8126510481.
2. R. Mead. (1990): "The Design of Experiments: Statistical Principles for Practical Application"; Cambridge Uni. Press. ISBN-10: 0521287626, ISBN-13: 978-0521287623.
3. Cochran W.G. and Cox G.M. (2003): "Experimental Designs"; 2nd Edition, John Wiley (wie) ISBN: 9971513110, ISBN-13: 9789971513115, 978-9971513115.
4. Cochran W.G. and Cox G.M. (1957): "Experimental Designs"; 2nd Edition, John Wiley & Sons Inc., New York, ISBN: 0471162035, ISBN-13: 9780471162032.
5. Das M.N. and Giri N.C.(1999) : "Design and Analysis of Experiments"; 2nd Edition, New Age International Publishers Ltd, ISBN: 0852269145, ISBN-13: 9780852269145.
6. Federer W.T. (1993) : "Statistical Design And Analysis For Intercropping Experiments"; Springer-verlag, ISBN: 0387979239, ISBN 13: 9780387979236, 978-0387979236.

7. Federer, W. T. (1955): “Experimental Design: Theory and Application”; The Macmillan Co., New York. ISBN 0387985336.
8. Klaus Hinkelmann, Kempthorne Oscar (2005): “Design and Analysis of Experiments”; Wiley-interscience, ISBN: 0471551775, ISBN-13: 9780471551775.
9. Kempthorne, O. (1952), The Design and Analysis of Experiments, John Wiley & Sons, New York ISBN:9780471551775
10. Fisher R. A. (2005): “Statistical Methods for Research Workers”; Cosmo Publications, ISBN: 8130701332, ISBN-13: 9788130701332, 978-8130701332.
11. Panse, V.G. and Sukhatme, P.V. (1978): “Statistical methods for agricultural workers”; ICAR, New Delhi.

Core-III
Course-403: Econometrics

Unit-I

Introduction:

- Review of Single Equation method OLS estimation: Estimation, Prediction, and tests of hypotheses, G.L.M. and generalized least squares estimation. Aitken's generalized least square (G.L.S) estimator
- Introduction to Econometrics and econometric models.
- Types of measurements and Data
- Problems with different types of data
- Problems associated with violation of assumptions of GLM

Unit-II

Multicollinearity:

- Nature and meaning of Multicollinearity.
- Consequences
- Detection
- Remedial Measures

Unit-III

Heteroscedasticity:

- Nature and meaning of Heteroscedasticity.
- Consequences
- Detection
- Remedial Measures

Unit-IV

Autocorrelation:

- Nature and meaning of Autocorrelation.
- Consequences
- Detection
- Remedial Measures

Unit-V

Dummy Variable Models:

- The Nature of Dummy Variables
- ANOVA Models
    - Caution in the Use of Dummy Variables
- ANOVA Models with Two Qualitative Variables
- Regression with a Mixture of Quantitative and Qualitative Regressors: The ANCOVA Models
- The Dummy Variable Alternative to the Chow Test
- Interaction Effects Using Dummy Variables
- The Use of Dummy Variables in Seasonal Analysis

Unit-VI

Stochastic Regressors and Instrumental Variable Estimation:

- Nature and meaning
- Parameter estimation and its properties
- Asymptotic properties
- Instrumental variable methods: Wald, Bartlett, Durbin, MLE.

Unit-VII

Simultaneous equation system:

- Structure and models, typology of economic relations, structural form, reduced form and final form of an economic, model.
- Problem of identification under linear homogeneous and Covariance restrictions. Rank and Order conditions of Identification
- Restrictions on structural parameters.
- **Methods of estimation:** Limited information and full information methods, indirect least squares. Two stage least squares.

REFERENCES

1. Damodar N. Gujarati, Dawn C. Porter: "Basic Econometrics"; McGraw Hill 2008. 5th edition. ISBN: 0071276254, 9780071276252
2. John Johnston, John Enrico DiNardo "Econometric Methods"; McGraw Hill, Kogakusha Ltd 2007. 4th edition. ISBN: 9780071153423
3. Koutsoyiannis, A.. Theory of Econometrics: An Introductory Exposition of Econometric Methods. Taiwan, Macmillan,2001. 2nd edition. ISBN: 9780333778227
4. Apte P.G.: "Text Book of Econometrics"; Tata McGraw Hill, 1990. ISBN:9780074515211, 0074515217
5. C. F. Charist: "Econometric Models and Methods"; John Wiley,1968. ISBN: 9780471156208, 0471156205
6. C.R. Rao, H. Toutenburg, Shalabh, and C. Heumann (2008): Linear Models and Generalizations - Least Squares and Alternatives, Springer Berlin Heidelberg,2008. 3rd edition. ISBN:9783540742272, 3540742271
7. Samprit Chatterjee, Bertram Price.: "Regression Analysis by Example"; John Wiley & Sons, 2015. 4th edition. ISBN:9780471015215, 0471015210
8. Cramer, Jan Salomon. Empirical Econometrics. Netherlands: North-Holland Publishing Company, 1971. 1st edition. ISBN:9780720430509, 072043050X.
9. Intriligator, Michael D.. Econometric models, techniques, and applications. India: Prentice-Hall, 1978. 7th edition. ISBN: 9780132232555, 0132232553.
10. Kendall, M. G., Stuart, A. The Advanced Theory of Statistics. United Kingdom: Griffin, 1968. 2nd edition. ISBN-13: **978-0470665305**
11. Klein, Lawrence Robert. An Introduction to Econometrics. United States, Greenwood Press, 1962. 2nd edition ISBN: 9780837198385, 0837198380.
12. Kmenta, Jan. Elements of econometrics. London, Macmillan, 1997 2nd edition. ISBN:9780023650703, 0023650702
13. Maddala, G.S Introduction to Econometrics. United Kingdom, Macmillan, 1992. 3rd edition. ISBN: 9780029460467
14. Recent Advances in Linear Models and Related Areas: Essays in Honour of Helge Toutenburg. Germany, Physica-Verlag HD, 2008. ISBN: 9783790820645, 3790820644.
15. Theil, Henri. Introduction to econometrics. United Kingdom, Prentice-Hall, 1978. ISBN:9780134810287, 0134810287.

Elective-I

Course-4041: Bio-Statistics & Clinical Research

UNIT I:

- Introduction to Bio-statistics, Sources of medical uncertainties, managing medical uncertainties. Applications of Bio-statistics as ascience.
- Clinical trials: the need and ethics of clinical trials, bias and random error in clinical studies, conduct of clinical trials, overview of Phase I-IV trials, multi-center trials. Data management: data definitions, data collection systems for good clinical practice,protocol definition.

UNIT II:

- Design of clinical trials: parallel vs. cross-over designs, cross- sectional vs. longitude designs, review of factorial designs, objectives and endpoints of clinical trials, design of Phase I trials,design of single-stage and multi-stage Phase II trials, design, and monitoring of Phase III trials with sequential stopping, design of bioequivalence trials.

UNIT III:

- Reporting and analysis: analysis of categorical outcomes from Phase I - III trials, analysis of survival data from clinical trials. Interim analysis method, motivating intent- to-treat analysis.

UNIT IV:

- Determining sample size. Surrogate endpoints: selection and designof trials with surrogate endpoints, analysis of surrogate endpoint data.

REFERENCES

1. Prem Narayan, Bhatia & Malhotra (1979): "Handbook of Statistical Genetics", Indian Agricultural Statistics Research Institute, I.C.A.R., New Delhi. Print ISSN: 0019-5200, Online ISSN: 0975-6906
2. J. P. Jain (1982): "Statistical techniques in quantitative genetics", 2nd ed., Hindustan Publishing corporation, ISBN-10: 8170750946, ISBN-13: 978-8170750949
3. Govindarajulu Z. (2000): "Statistical Techniques in Bioassay", 2nd revised edition, Karger, ISBN-10: 9783805571197, ISBN-13: 978-3805571197
4. Finney, D.J (1971): "Statistical Method In Biological assay", 2nd ed., C. Griffin and company limited. ISBN-10: 0852640145, ISBN-13: 978-0852640142
5. Finney, D.J (1971): "Probit Analysis" 3rd ed., Cambridge University Press, Cambridge, ISBN: 9780521080415, 052108041X
6. Wetherill, G. Barrie (1966): "Sequential Methods in Statistics", Methuen, ISBN 10: 0416523900, ISBN 13: 9780416523904
7. S. Piantadosi (1977): "Clinical Trials: A Methodologic Perspective", 3rd ed., Wiley and Sons, ISBN: 978-1-118-95920-6
8. Jennison, C. and Turnbull, B.W (1999): "Group Sequential Methodswith Applications to Clinical Trials", 1st edition, CRC Press, E-book ISBN: 9780367805326
9. J. L. Fleiss (1989): "The Design and Analysis of ClinicalExperiments". 1st ed., Wiley and Sons, ISBN: 978-1-118-03117-9
10. Ettore Marubini, Maria Grazia Valsecchi (2004): "Analyzing Survival Data From Clinical Trials and Observational Studies", 1st ed., Wiley and Sons. ISBN: 978-0-470-09341-2
11. Lawrence M. Friedman, Curt D. Furberg, David L. DeMets (1998): "Fundamental of clinical Trials", 3rd ed. Springer Publication, ISBN 978-1-4419-1585-6 e-ISBN 978-1-4419-1586-3

12. Duolao Wang, Ameet Bakhai (2006): “Clinical Trials A Practical Guide to Design, Analysis, and Reporting”, Published by Remedica, USA, ISBN-10: 1 901346 72 2, ISBN-13: 978 1 901346 725
13. Indrayan and L. Satyanarayana (2006): “Biostatistics for medical, nursingand pharmacy students”, Eastern Economy Edition, Prentice hall India, ISBN 81-203-3054.
14. B. K. Mahajan (1997): “Method in Biostatistics for medical students and research work”, Sixth edition, Jaypee Brothers medical publisher LTD. ISBN 81-7179-520-X.

Elective II

Course 4042: Economic & Business Statistics

UNIT I:

Index Numbers: Price, Quantity and Value indices. Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Chain Index Number. Consumer Price Index, Wholesale Price Index and Index of Industrial Production – Construction of index numbers and uses. Cost of Living Index Number and various Official Index Numbers, HDI (Human Development Index).

UNIT II:

Demand Analysis: Concept related to demand and supply, price elasticities of demand and supply, Methods of determining demand and supply curves for cross section data and time series data, Leontief's method, Pigou's Method, Engels Curves, Pareto's Law of Income Distribution.

UNIT III:

Time Series Analysis: Definition and importance of time series analysis. Components of a Time series. Different methods for determination of trend, Methods for elimination of seasonal components. Determination of cyclic components. Variate difference method and their merits and demerits.

UNIT IV:

Stationary Time series, Box-Jenkins Models, Introduction to Autoregressive (AR) Models, Moving Average (MA) Models, Mixed Autoregressive Moving Average (ARMA) Models. Autoregressive Integrated Moving Average (ARIMA) Models. Properties of these models. Forecasting Techniques, Seasonal ARIMA model, Introduction to conditional Heteroscedasticity model; Volatility models, ARCH model, GARCH model, properties, estimation and forecasting of these models.

REFERENCES

1. Allen R. G. D. (1975). Index Numbers in Theory and Practice, Macmillan. ISBN: 9781349023141.
2. Kendall M. : "Time Series"; Charles Griffin and Company. ISBN-10. 0195207068
3. Box and Jenkins: Time Series Analysis: Forecasting and Control; Holden Day Pub, ISBN-13. 978-0816211043.
4. Chatfield C. : The Analysis of Time Series : Theory and Practice; Chapman and Hall, ISBN-13: 978-0412716409.
5. Waller Vancuels : Applied Time Series and Box Jenkins Models, ISBN 13: 9780127126500.
6. Karmel P.H. : "Applied Statistics for Economics", ISBN-13. 978-0273402954.
7. Sen A.K.: Growth Economics: Penguin Modern Economic Reading Edition, ISBN 13: 9780140801392.
8. Mukhopadhyay P. : Applied Statistics; New Central Book Agency(P) Ltd, ISBN : 8187134380, 9788187134381.
9. Gupta S.C. and Kapoor V.K.: Fundamentals of Applied Statistics; Sultan Chand & Sons, ISBN 13: 978-8180547058
10. Anderson. T. W. (1971). The Statistical Analysis of Time Series Wiley, N. Y, ISBN-13: 978-0471029007
11. Montgemory, D. C. Johnson L. A (1990) Forecasting and Time Series Analysis, McGraw Hill, ISBN 9780471653974.

Skill Based Course

Course-406: Programming Language 'R'

UNIT I:

- **Introduction to R**
  - Background and resources
  - Installing R and R Studio
  - R console.
  - R commander
  - Command and syntax
  - Packages and libraries
  - Help in R
  - Workspace in R
- **Data Structures**
  - Introduction to data structure
  - Vectors
  - Matrices
  - Arrays
  - Lists
  - Factors
  - Data frames
  - Importing and Exporting data
  - Data types
- **Data management**
  - Split
  - Find and replacement
  - Manipulations with alphabets
  - Evaluation of strings
  - Data frames.
- **Conditional executions and loops**
  - If loop
  - While loop
  - For loop

UNIT II: Statistical Analysis in R

- **Data Visualization of R**
  (Creating, Modifying the points, line, title, subtitle, axes of the plot/graph, Adding additional elements and legends to graph etc.)
  - Pie Chart
  - Bar graph
  - Line Graph
  - Scatter plot

- Stack Plot
- Box-Plot
- Special graph
- Multiple plots

- **Frequencies & Descriptive Statistics**

- Frequency
- Measure of central tendency
- Measure of Dispersion
- Measure of skewness

- **Statistical Testing**

- Cross tabulation
- One sample t test
- Independent sample t test
- Paired sample t test
- One way ANOVA

- **Statistical Modelling**

- Correlation
- Simple linear regression
- Multiple linear regression

REFERENCES

1. R, Second edition" , Narosa Publishing House, ISBN-978-81-8487-455-6
2. Dr. Mark Gardener (2015), "Beginning R: The statistical programming language", Wiley, ISBN-978-81-265-4120-1
3. Jared P. Lander (2014), "R for everyone advance analytics and graphics", Addison Wesley data & analytics series, Dorling Kindersley (India) Pvt. Ltd., ISBN-978-93-325-3924-2
4. Yanchang Zhao and Yonghua Cen (2014), "Data mining application with R",Elsevier, ISBN-978-93-5107-218-8
5. Nina Zumel and John Mount (2015), "Practical data science with R", Dreamtech Press, ISBN-978-93-5119-437-8
6. Paul D. Lewis (2010), "R for medicine and biology", Jones and Bartlett Publishers, ISBN-978-0-7637-5808-0.