Re-Accredited 'B++' 2.86 CGPA by NAAC
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વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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–: પરિપત્ર :–

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન આંકડાશાસ્ત્ર (Statistics) કોર્સ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ તથા વિભાગીય વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૪–૨૫ થી અમલમાં આવનાર M.Sc. Statistics (Sem-3 and 4) નો & M.Sc. Applied Statistics (Sem-3 and 4) નો અભ્યાસક્રમ આંકડાશાસ્ત્ર વિષયની અભ્યાસસમિતિનાં ચેરમેનશ્રીએ અભ્યાસ સમિતિ વતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજુરીની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણને એકેડેમિક કાઉન્સિલની તા.૦૧/૦૩/૨૦૨૪ ની સભાનાં ઠરાવ ક્રમાંકઃ૧૦૪ અન્વયે માન.કુલપતિશ્રીને આપેલ સત્તા અંતર્ગત માનનીય ઈ.ચા.કુલપતિશ્રી ધ્વારા મંજૂર કરેલ છે. જેની આથી જાણ કરવામાં આવે છે.

(બિડાણઃઉપર મુજબ)

ક્રમાંક : એસ./આંકડાશાસ્ત્ર/પરિપત્ર/૧૦૦૭૦/૨૦૨૪
તા.૧૪–૦૫–૨૦૨૪

કુલસચિવ ઇન્ચા

પ્રતિ,
૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન આંકડાશાસ્ત્ર કોર્સ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ. તથા વિભાગીય વડાશ્રી. .....આપશ્રીની કોલેજ/વિભાગના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારૂ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

Syllabi

of

M. Sc. (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	NON-PARAMETRIC INFERENCE	4	3	30	70	100	4
CORE-II	302	LINEAR MODEL	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	STATISTICAL COMPUTING USING SPSS	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: Nonparametric Inference

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

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Core-II

Course: 302: Linear Model

UNIT I:

- **Introduction**
- T**he general linear model: Gauss-Markoff set up**
  - **Simple Linear Regression:** Normal equations andOrdinary Least Squares Estimation, Least Squares Criterion, Properties of Least Squares Estimates, Confidence Intervals and *t*-Tests, The Coefficient of Determination, R^2,The Residuals.
  - **Multiple Regression:** Predictors and Regressors, Ordinary Least Squares, Properties of the Estimates, Hypotheses Concerning Coefficient, Predictions, Fitted Values, and Linear Combinations.

UNIT II:

Generalized Least Squares:

- Normal equations and least squares estimate
- Properties and Theorems
- Estimation of linear parametric functions, variances and covariance of least square estimates, estimation with correlated observations, Aitken's Criterion

UNIT III

- **Estimation under restrictions:** Least squares estimates with restrictions on parameters
- Simultaneous estimates of linear parametric functions
- Error and Estimation spaces.
- Generalised Inverse

UNIT IV:

Quadratic forms:

- Estimation of scale parameter in the general linear model by quadratic functions.
- Necessary and sufficient conditions for a
  (i) quadratic form to be distributed as chi-square
  (ii) Independence of a linear form and a quadratic form
  (iii) Independence of two quadratic forms.
- Cochran's theorem and its generalizations.

UNIT V:

- The General Linear Hypotheses
  - Testing linear hypotheses
  - Estimation under null hypothesis
  - The likelihood ratio test
  - ANOVA- one way and two-way classification

UNIT-VI:

- **Count Data 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 Regression

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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.

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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.

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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

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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.

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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: Statistical Computing Using SPSS

UNIT I:

SPSS Introduction :

- Starting SPSS
- Types of Data
- Levels of Measurement
- Missing Values
- Important Files // database files

Data Management

- Selecting Cases
- Standardizing Data

Data Transformation

- Transformation of Data
- Split File
- Variable and Value Labels
- Recode Variables/Visual Binning
- Random Sample of the Data
- Creating a Population Variable
- Multi Response

UNIT II:

- **Basic Data Analysis**
- Descriptive Statistics
- Frequency Tables/Cross Tabs
- Parametric test
- Nonparametric test
- Correlation & Regression

REFERENCES

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4. Gaur A. S. and Gaur S. S(2009).: "Statistical Methods for Practice and Research- A guide to data analysis using SPSS"; 2nd Ed., Sage Publications, New Delhi.
5. George: "SPSS For Windows: Step By Step"; 8th Ed., Pearson, ISBN: 8131724298, 9788131724293.
6. Andy Field: " Discovering Statistics using SPSS" 3rd Ed., Sage Publications, ISBN: 978-1-84787-906-6
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Syllabi

of

M. Sc. (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	4	3	30	70	100	4
CORE-II	402	DESIGN OF EXPERIMENTS	4	3	30	70	100	4
CORE-III	403	ECONOMETRICS	4	3	30	70	100	4
ELECTIVE-I	4041	BIOSTATISTICS & CLINICAL RESEARCH	4	3	30	70	100	4
ELECTIVE-II	4042	STATISTICS FOR ECONOMICS						
ELECTIVE-III	4043	PROJECT/ DISSERTATION						
PRACTICAL BASED ON 301 TO 3044 USING EXCEL, JAMOVI, SPSS & 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 STUDENS			30		190	410	600	24
TOTAL HRS FOR THE DEPTT.			26(Fixed for theory paper)+12/batch of practical+ 4 hrs /project group/dissertation =26+(12*No. of practical batches) +(4*No. of project groups/dissertations)					

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

Core-I

Course 401: Operations Research

UNIT I:

(Quick revision of Linear Programming Problem)

- 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:

- Goal Programming:
- Definitions and Concepts
- Formulation of Goal Programming Problem (GPP)
- Solution of GPP by Graphical and Extended Simplex Methods
- 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

UNIT IV:

- Replacement Theory:
- Types of Replacement Problem
- Replacement of Items that Deteriorate
- Replacement of Items that fails completely and that of Staff
- Sequencing Problems:
- 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

REFERENCES

1. K. Swarup, Gupta P.K. and Man Mohan(2008): "OperationsResearch"; S. Chand & Co., New Delhi, ISBN: 8180545350, ISBN: 13: 9788180545351
2. G. Hadley (2002): "Linear Programming"; Narosa Book DistributorsPvt Ltd, ISBN: 8185015910, ISBN-13: 9788185015910
3. Murthy K.G.(1988): Linear complementarity, linear and nonlinearprogramming, Heldermann Verlag, ISBN: 3885384035,9783885384038
4. Kasana H.S. and Kumar K.D.(2005) : "Introductory OperationResearch: Theory & Applications"; Springer Verlag , ISBN:8181282827, 9798181282827.
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6. Sharma S.D.(2005): Operations Research"; 15th Ed., Kedar Nath Ram Nath & Co. Publishers, Meerut,
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9. Rathindra P. Sen (2010): "Operations Research Algorithms and Applications" PHL Learning PVT. LTD., ISBN: 978-81-203-3930-9

Core – II
Course 402: Design of Experiments

UNIT I:

- General properties of incomplete block design; Concepts of connectedness, balance and Orthogonality.
- Construction of MOLS and their application.

UNIT II:

- Balanced incomplete block design (BIBD)
- Symmetric balanced incomplete block designs
- Resolvable BIBD, Affine Resolvable BIBD.
- Intra Block Analysis of BIBD

UNIT III:

- General theory of analysis of experimental designs with one way and two way elimination of heterogeneity (intrablock analysis only).
- Missing plot technique, its application to randomized block, Latin square and balanced incomplete block designs.
- Youden square and Crossover design.

UNIT IV:

- General theory of symmetric factorial experiments; concepts of total and partial confounding and 2^n confounded experiments.
- Construction of total and partially confounded symmetric 2^n factorial experiments.

REFERENCES

1. Montgomery, D. C. (2006): "Design and Analysis of Experiments"; 5thEd, Wiley (India), ISBN: 812651048X, ISBN-13: 9788126510481,978-8126510481.
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4. Cochran W.G. and Cox G.M. (1957): "Experimental Designs"; 2ndEdition, 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 ForIntercropping 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 ofExperiments"; Wiley-interscience, ISBN: 0471551775, ISBN-13:9780471551775.
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11. Panse, V.G. and Sukhatme, P.V. (1978): "Statistical methods foragricultural 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 Hill2008. 5th edition. ISBN: 0071276254, 9780071276252
2. John Johnston, John Enrico DiNardo "Econometric Methods"; McGraw Hill, Kogakusha Ltd2007. 4th edition. ISBN: 9780071153423
3. Koutsoyiannis, A.. Theory of Econometrics: An Introductory Exposition of Econometric Methods. Taiwan, Macmillan,2001. 2nd edition. ISBN: 9780333778227
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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.
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15. Theil, Henri. Introduction to econometrics. United Kingdom, Prentice-Hall, 1978. ISBN:9780134810287, 0134810287.

Course-4041:Bio-Statistics&ClinicalResearch

UNITI:

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

UNITII:

- 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

UNITIII:

- 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.

UNITIV:

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

REFERENCES

1. Prem Narayan, Bhatia & Malhotra (1979):"Hand book of Statistical Genetics",Indian Agricultural Statistics Research Institute, I.C.A.R., New Delhi. Print ISSN: 0019-5200, Online ISSN: 0975-6906
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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
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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 IndexNumbers: Construction, Uses, Limitations, Tests for indexnumbers, Chain Index Number. Consumer Price Index, WholesalePrice Index and Index of Industrial Production – Construction ofindex numbers and uses. Cost of Living Index Number and variousOfficial 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 forcross section data and time series data, Leontief's method, Pigou'sMethod, 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 toAutoregressive (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.
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7. Sen A.K.: Growth Economics: Penguin Modern EconomicReading Edition, ISBN 13: 9780140801392.
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Course 405 : Practical Paper –IV

Based on Theory Paper 401 to 404

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.