# PERIYAR UNIVERSITY
## SALEM -636 011.

**M.Sc. STATISTICS**

**SYLLABUS**

**Effective for the candidates admitted from 2008-2009 onwards**

# Course Structure under CBCS

## BRANCH II – STATISTICS- Course Title: M. Sc. (Statistics)

(For the candidates admitted from the year 2008 onwards)

| Semester | Course | Course Title | Hours | Credit | Internal Mark | External Mark | Total Marks |
|---|---|---|---|---|---|---|---|
| I | Core I | Real Analysis and Linear Algebra | 6 | 5 | 25 | 75 | 100 |
| | Core II | Measure Theory | 6 | 5 | 25 | 75 | 100 |
| | Core III | Distribution Theory | 6 | 5 | 25 | 75 | 100 |
| | Core IV | Sampling Theory and Methods | 6 | 5 | 25 | 75 | 100 |
| | Core V | Practical -I | 6 | 4 | 40 | 60 | 100 |
| | | **Total** | **30** | **24** | **140** | **360** | **500** |
| II | Core VI | Probability Theory | 5 | 4 | 25 | 75 | 100 |
| | Core VII | Multivariate Analysis | 5 | 4 | 25 | 75 | 100 |
| | Core VIII | Demography | 5 | 4 | 25 | 75 | 100 |
| | Core IX | Practical-II | 4 | 3 | 40 | 60 | 100 |
| | Elective-I | Reliability Theory | 5 | 4 | 25 | 75 | 100 |
| | EDC * | | 4 | 4 | 25 | 75 | 100 |
| | | Human Rights | 2 | 2 | 25 | 75 | 100 |
| | | **Total** | **30** | **25** | **190** | **510** | **700** |
| III | Core X | Statistical Estimation Theory | 6 | 5 | 25 | 75 | 100 |
| | Core XI | Design of Experiments | 6 | 5 | 25 | 75 | 100 |
| | Core XII | Practical-III | 6 | 3 | 40 | 60 | 100 |
| | Elective-II | Statistical Quality Control | 6 | 4 | 25 | 75 | 100 |
| | Elective-III | Operations Research | 6 | 4 | 25 | 75 | 100 |
| | | **Total** | **30** | **21** | **140** | **360** | **500** |
| IV | Core XIII | Testing Statistical Hypotheses | 6 | 5 | 25 | 75 | 100 |
| | Core XIV | Practical-IV | 6 | 3 | 40 | 60 | 100 |
| | Elective-IV | Stochastic Processes | 6 | 4 | 25 | 75 | 100 |
| | Elective-V | Actuarial Statistics | 6 | 4 | 25 | 75 | 100 |
| | Project Work | | 6 | 4 | 40 | 60 | 100 |
| | | **Total** | **30** | **20** | **155** | **345** | **500** |
| | | **Grand Total** | | **90** | | | **2200** |

* Extra Disciplinary Course

## List of Core/Elective Subjects to be offered

## CORE Subjects

1. Real Analysis and Linear Algebra
2. Measure Theory
3. Distributions Theory
4. Sampling Theory and Methods
5. Practical – I
6. Probability Theory
7. Multivariate Analysis
8. Demography and Actuarial statistics
9. Practical – II
10. Statistical Estimation Theory
11. Design of Experiments
12. Practical – III
13. Testing Statistical Hypotheses
14. Practical – IV
15. Project & VIVA-VOCE

## ELECTIVE Subjects

1.Reliabilty Theory.
2.Statistical Quality control.
3.Operartions Research.
4.Stochastic processes.
5. Actuarial statistics.
6.Applied Regression Analysis.
7. Statistical Computing
8. Econometrics.

## Extra Disciplinary Course:

1. Statistical Methods
2. Elements of Operations Research

**Human rights**. Common to all courses. Syllabus will be provided by the University.

## Examination:

The examination shall be three hours duration to each paper at the end of each semester. The candidate failing in any course will be permitted to appear in the subsequent semester.

Practical examinations should be conducted at the end of even semester.

At the end of fourth semester, vivo-voce will be conducted on the basis of Project/Dissertation submitted by the student .The vivo-voce should be conducted by the guide and the external examiner.

### Theory Papers:

Total mark for each course (core/elective) is 100. 25 marks for Internal and 75 marks for University Examination. The Internal Assessments may be in the form of Combination of Periodical tests and Assignments for theory papers. The components are:

| | |
|---|---|
| **1. Attendance** | **= 5 Marks** |
| **2. Assignment** | **= 5 Marks** |
| **3. Test** | **= 10 Marks** |
| **4. Seminar** | **= 5 Marks** |
| **Total** | **= 25 Marks** |

## Practical:

Total mark for each practical course (core/elective) is 100. 40 marks for internal and 60 marks for Written Examination. The Internal Assessments may be in the form of Combination of Periodical tests and Record work for practical.

The components are:

| | |
|---|---|
| **1.Attendence** | **= 5 Marks** |
| **2.Record work** | **= 25 Marks** |
| **3.Test** | **= 10 Marks** |
| **Total** | **= 40 Marks** |

## Project work:

The Marks for the Project work is 100 and the components are:

| | |
|---|---|
| **Internal Assessments:** | **: 40 Marks** |
| (For two reviews 20+20 = 40) | |
| **Evaluation :** | |
| Evaluation of Project report by External Examiner and Guide | : **40 Marks** |
| Viva-Voce conducted by | |
| Supervisor and External Examiner | : **20 Marks** |
| **Total** | **: 100 Marks** |

# Question Paper Pattern:

- Total mark for each course ( University examination) is 75.
- The Question paper is divided into two parts.
- **PART-A** consists of 5 questions, one from each unit with internal choice. Each question carries 5marks. All questions should be answered. Total marks for PART-A is **25**.
- **PART-B** consists of 5 questions, one from each unit with internal choice. Each question carries 10marks. All questions should be answered. Total marks for PART-B is 50.

# SYLLABUS

**Core Course I** **REAL ANALYSIS AND LINEAR ALGEBRA**

**Unit I**

Introduction to real numbers, n-dimensional Euclidian space, open and closed intervals (rectangles), Compact sets. Bolzono-Weirstrass theorem, Heine - Borel theorem.

**Unit II**

Sequence and series of function. Uniform convergence and its applications (without proof).Real valued function of several variables-Limit, continuity and derivability of function.

**Unit III**

Characteristic roots and vectors.Caley-Hamilton theorem. Minimal polynomials-similar matrices-Algebraic and geometric multiplicity of a characteristic root-Spectral decomposition of a real symmetric matrix-reduction of a pair of real symmetric matrices.Hermition matrices.

**Unit IV**

Real quadratic forms, reduction and classification of quadraticforms-extrema of quadratic forms-index and signature. Reduction of positive definitive matrix.

**Unit V**

Generalized Inverse of a matrix .Moore and Penrose generalized inverse in the solution of system of equation. Least square properties of Moore and Penrose generalized inverse. Application of M-P inverse for the solution of optimization problems.

**Books for Study and Reference:**

1. Goldberg, R. (1970): **Methods of Real Analysis**, Oxford and IBH publishing Co Pvt Ltd.
2. Apostol, T.M. (1985): **Mathematical Analysis**, Naraso publishing, New Delhi.
3. Rudin Walter. (1976): **Principles of Mathematical Analysis**, McGraw Hill.
4. Rao, A.R., and BhimaSankaran(1992):**Linear Algebra**, Tata McGraw Hill.
5. Rao, C.R., and Mitra, S.K. (1971): **Generalized inverse of matrices and its applications**, John Wiley and Sons Inc.

**Core Course II** **MEASURE THEORY**

**Unit I**

Algebra of sets-Countable sets – field –monotonic field-monotonic class-field generated by a class of subsets-Borel sets- Borel field.

**Unit II**

Set functions – countably additive set functions – finitely additive set functions. Measure functions. properties of measure functions – Outer measure functions –Extension measure –completion of a measure function (concepts only).

**Unit III**

Lebesgue measure and its properties. Lebesgue- Stieltjes measure-examples-Measurable functions- Borel measurable functions –Approximation theorem.

**Unit IV**

Measure integration – Properties of integrals – sequence of Measurable functions – mode of convergence of measurable functions – monotone and dominated convergence theorems.

**Unit V**

Product measure –product measure functions-properties – Product measure theorem – Fubini's theorem (concept) and its applications in probability.Radon-Niokodym theorem (concept) and its applications.

**Books for Study and Reference:**

1. Munroe, M.E. (1953): **Measure and Integration**, Addition Wesley Ltd.,

2. De BarraG. (1991):**Measure theory and Integration**, Wiley Eastern Ltd.,

3. Royden ,H.L.(1968): **Real Analysis**, 2nd Edition, Macmillan, 1968.

**Core Course III** **DISTRIBUTION THEORY**

**Unit I**

Distribution of sum, difference, quotient and product of two independent random variables using Jacobian transformation and other tools. Conditional expectation and conditional variance.

**Unit II**

Simple, partial and multiple correlations and regressions (concept and simple problems only). Bivariate Normal distribution and its properties.

**Unit III**

Multivariate Normal distribution and multinomial –properties-marginal and conditional distributions (simple problems only).

**Unit IV**

Non-central $\chi^2$, t and F distributions. Compound, truncated and mixture distributions. (Simple problems only).

**Unit V**

Distribution of Quadratic forms under normality-Necessary and sufficient for quadratic form to have $\chi^2$ distribution. Independence of two quadratic forms. Cochran's theorem. Order statistics-properties- joint and marginal distributions-Distribution of Median and Range.

**Books for Study and Reference:**

1. Hogg, R.V and CraigA.T. (1972): **An Introduction to Mathematical Statistics**, 3rd Edition, Amerind.

2. Rohatgi, V.K. (1988): **An Introduction to probability theory and Mathematical Statistics**, Wiley Eastern.

3. Anderson.T.W. (1983): **An Introduction to Multivariate Statistical Analysis**, 2nd Edition, John Wiley.

4. Johnson and Kotz: **Distributions in Statistics**, Vol I, II and III, Wiley.

5. Kshirsagar, A.M. (1972): **Multivariate Analysis**, Marshall Dekker.

**Core Course IV** **SAMPLING THEORY AND METHODS**

**Unit I**

Principal steps in a sample survey– Drafting a questionnaire .Errors in Surveys-Non Response, types of Non-Response, Call -Backs, a mathematical model of the effects of Call-Backs. Interpenetrating sub sample.

Randomized response Technique: Warner's model-related and unrelated questionnaire method.

**Unit II**

Finite population sampling techniques: SRSWR/WOR, stratified and systematic and related results on estimation of population and mean/total –

Allocation problems in stratified random sampling.

**Unit III**

Ratio and Regression estimators based on SRSWOR and stratified random sampling. Multivariate ratio estimator (concept only)

Cluster sampling – clusters of equal size – Estimation of mean and its Variance.

**Unit IV**

Unequal probability sampling: PPSWR/WOR. Cumulative total and Lahiri 's scheme .Methods and related estimators of finite population mean/total. Hurwitz – Thompson estimators – Des Raj ordered estimator and Murthy's unordered estimator.

**Unit V**

Two stage sampling with equal first stage units – estimation of mean and its variance. Double Sampling: Double sampling for stratification – DS for Ratio estimator – DS for Regression estimator.

**Books for Study and Reference:**

1. Singh, D. and Choudhary F.S.(1986): **Theory and analysis of sample survey Designs**, Wiley Eastern Limited.

2. Cochran W.G. (1977): **Sampling Techniques**, Wiley Limited, 1977.

3. Des Raj. (1967): **Sampling Theory**, Tata McGraw Hill, New Delhi.

4.Parimal Mukhopadhyay. (1988): **Theory and Methods of Survey Sampling**, Prentice Hall of India.

**Core Course V** **PRACTICAL –I**

(**Based on Core courses: Distribution theory and Sampling Theory and Methods)**

The Maximum mark is 100 with 40marks for Internal involving Test and Record work.60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each with 20 marks .The Core Practical-I examination should be conducted at the end of II Semester.

**Unit I:**

(a) Finding partial, multiple correlation and Regression coefficients
(b) Testing partial, multiple correlation and Regression coefficients
(c) Fitting the curves linear exponential, modified exponential and Power curves

**Unit II**:

(a) Fitting normal distribution and testing goodness of fit.
(b) Fitting lognormal distribution and testing goodness of fit.
(c) Testing Ho: $\mu = \mu_0$ when $\sum$ is known.
(d) Testing Ho: $\mu^{(1)} = \mu^{(2)}$ when $\sum$ is known.

**Unit III**:

(a) Estimation of population mean, total and its variance is SRS.

(b) Estimation of population mean, total and its variance by Ratio estimation (SRS).

(c) Estimation of population mean, total and its variance by Regression Estimation (SRS).

**Unit IV:**

(a) Estimation of population mean, total and SE in stratified Random Sampling

(b) Comparisons of difference allocations in STRS.

(c) Gain due to stratifications.

(d) Estimation of population mean, total and SE in Systematic sampling.

(e) Estimation of mean, total and variance in Cluster sampling.

**Unit V**:

(a) Estimation of mean ,total and variance in two stage cluster sampling with equal size clusters

(b) PPS sampling with replacement.

(c) Double sampling for stratification.

(d) Double sampling for Ratio estimation

(e) Double sampling for Regression estimation.

**Core Course VI** **PROBABILITY THEORY**

**Unit I**

Probability measure – properties – Discrete probability space and general probability space, conditional probability space. Functions and inverse functions – Random variables – Induced probability space by random variables.

**Unit II**

Distribution functions – properties – Decomposition theorem – Correspondence theorem – Distribution function of vector r.v - conditional distribution function – properties – Concept of Independence – Kolmogorov 0-1 Law – Borel Cantelli Lemma.

**Unit III**

Expectation and moments – properties , conditional expectation – properties. Inequality – Markov, Holder, Jenson , Chebyshev's and Liaponov. Convergence of sequence of random variables – mode of convergence and their relationship.

**Unit IV**

Characteristics Function of random variables – properties – Inversion theorem – Simple examples – Uniqueness theorem, Levy continuity theorem (statement). Law of Large numbers – WLLN for independent and i.i.d case – SLLN for independent and i.i.d case.

**Unit V**

Weak and complete convergence of distribution function – Helly Bray theorem. Central Limit theorem -generalization of LLN, CLT for independent random variables – Liapounov's form – Lindeberg – Feller, CLT for i.i.d random variables – Lindeberg – Levy theorem.

**Books for study and References**


1. Bhat,B.R. (1981): **Modern Probability Theory**, Wiley Eastern Ltd. New Delhi.

2. Rohtgi,V.K.(1985):**An Introduction to Probability Theory and Mathematical Statistics,** Wiley Eastern Ltd.

3. Leove, M. (1963): **ProbabilityTheory, Van.Nostrains, PrincetonPublishing**, Moscow.

4. Billingsley, P (1985): **Probabilty and Measure**, Wiley Eastern Ltd.

5. Ash, R.B. (1972), **Real Analysis and Probability**, Academic process.

**Core Course VII** **MULTIVARIATE ANALYSIS**

**Unit I**

MLE's for parameters of Multivariate normal distribution. MLE's of Total ,partial and multiple correlations – Regressions – Distribution of sample mean vector – Null distributions of total ,simple, multiple Correlation Coefficients and regression coefficients

**Unit II**

Hotelling's $T^2$ statistics – its Null distribution – its relation with LR test criterion and Mahalanobis – $D^2$, Wishart matrix – its distribution and properties.

**Unit III**

Testing for mean vectors (with known and unknown dispersion matrix) and dispersion matrix (Large sample test)of one and two multivariate normal distributions.

**Unit IV**

Classification and discrimination procedures among two multivariate normal populations only – probabilities of misclassification and their estimation .Fisher's discriminant function – sample discriminant function – Tests associated with discriminant function – concept of cluster analysis.

**Unit V**

Principal Component – dimension reduction – Canonical correlation and variables – definition ,use ,estimation and computation – Factor analysis – Orthogonal factor model, principal component solution to factor model – Concept of path analysis – construction of path diagram and its use in linear regression model .

**Books for study and Reference**


1. Anderson, T.W. (1983): **An introduction to Multivariate Statistical Analysis,** 2nd edition John Wiley.
2. Johnson and Wichern.(1996): **Applied Multivariate Statistical Analysis**"3rd edition, PHI (p) Ltd.
3. Giri, N.C. (1977): **Multivariate Statistical inference**, Academic press.
4. Harison D.F. (1978): **Multivariate Statistical Methods**, Academic 2nd edition McGraw Hill.
5. Rao, C.R. (1973): **Introduction to Linear Statistical Inference and its Applications**, Wiley Eastern.

**Core Course - VIII** **DEMOGRAPHY**

**Unit I**

Coverage and content errors in demographic data, use of balancing equations and Chandrasekaran- Deming formula to check completeness of registration data .Adjustment of age data – use of Whipple, Myer and UN indices. Population composition, dependency ratio.

**Unit II**

Measures of fertility: stochastic models for reproduction, distributions of time to first birth, inter-live birth intervals and of number of births (for both homogeneous and non-homogeneous groups of women),estimation of parameters: estimation of parity progression ratios from open birth interval data.

**Unit III**

Measures of mortality: construction of abridged life tables. Distribution of life table functions and their estimation.

**Unit IV**

Stable and quasi-stable populations, intrinsic growth rate. Models for population growth and their fitting to population data. Stochastic models for population growth.

**Unit V**

Stochastic models for migration and for social and occupational mobility based on markov chains. Estimation of measures of mobility.

**Books for study and reference:**


1.Cox,P.R(1970): **Demography**. Cambridge University Press.

2.Benjamin,B(1969):Demographic Analysis, George, Atlen .

3..Bartholomew, D.J. (1982): **Stochastic Model for Social processes**, John Wiley.

4..Suddhendu Biswas (1988):**Stochastic Process in Demography and its Applications**, Wiley Eastern Ltd, New Delhi.

5..Ramkumar.R.(1986):**Technical Demography**, Wiley Eastern Ltd, New Delhi

6..Keyfitz, O.R. (1977): **Applied Mathematical Demography**, Springer Verlog.

7..Rogers, A.(1975):**Introduction to Mathematical Demography**, John Wiley & Sons, New York

**Core Course - IX** **PRACTICAL – II**

**(Based on papers: Multivariate Analysis, Demography)**

The Maximum mark is 100 with 40marks for Internal involving Test and Record work.60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each with 20 marks .The Core Practical-II examination should be conducted at the end of II Semester.

**Unit I**

(a) MLE's for $\mu$ and $\sum$ in a p- variate Normal distribution.

(b) Testing $H_{o:}\ \mu = \mu_o$ When $\sum$ is unknown.

(c) Testing $H_{o:}\ \mu^{(1)} = \mu^{(2)}$ When $\sum$ is unknown.

**Unit II**

Test for dispersion matrix of p- variate Normal distribution (All Asymptotic tests)

(a) $H_o: \sum = \sum_0$

(b) $H_o: \sum_1 = \sum_2$

(c) $H_o: \mu = \mu_o$ and $\sum = \sum_0$

**Unit III**

(a) Finding Fisher's discriminant function (two population case only)

(b) Test for assigned discriminant function

(c) Discriminant function use in classification and probability of misclassification.

(d) First principal component and its variance –Extraction method.

(e) Construction of Abridged life tables (Reed and Marrell).

(f) Construction of Abridged life tables (JIA).

(g) Construction of Abridged life tables ( Greville).

**Unit IV**

Fitting of Population Growth Models.

(a) Gompertz's Law.

(b) Makeham's Law.

(c) Logistic Law (Method of partial sums).

(d) Logistic Law (Method of three selected points).

**Unit V**

(a) Computation of Mobility measures.

(b) Probability of living and dying rate of mortality.

(c) Estimation of and other measures from mortality table.

**Core Course - X** **STATISTICAL ESTIMATION THEORY**

**Unit I**

Criteria of Point Estimation – Standard parametric models of distributions – Consistent estimation of real valued parameters. Invariance of consistent estimators. Ubnbiasedness, Sufficiency, Neyman Factorization criterion, Exponential families, distribution admitting sufficient statistics.

**Unit II**

Completeness, Bounded completeness, Minimal Sufficient statistics, Method of constructing minimal sufficiency statistics- minimum variance unbiased estimators. Rao - Blockwell theorem, Lehmann- Scheffe theorem.

**Unit III**

Necessary and sufficient condition for UMVUE-Inequality approach to **UMVUE**-Fisher measure of Information. Cramer-Rao Inequality. Different forms of Cramer- Rao Inequality-Chapman –Robbins bound. Efficiency of an estimator-Extension of Cramer-Rao Inequality. Bhattacharya bound.

**Unit IV**

Method of Maximum Likelihood Estimation. Cramer and Hurzubazar theorems-Solution of likelihood equations-Method of scoring- Method of minimum variance bound estimation – Method of moments estimation. Method of minimum Chi-square estimation and Method of least square estimation.

**Unit V**

Interval estimation – confidence level, construction of confidence intervals using pivots, shortest confidence interval, Bayes estimation – Bayes minimax estimation.

**Books for study and reference:**


1. Santhakumarn. A,(2004):**Probability Models and their Parametric Estimation**, K.P.Jam publication, Chennai.

2. Rohatgi, V. (1988): **An Introduction to Probability and Mathematical Statistics**," Wiley Eastern Ltd, New Delhi.

3. Lehmann, E.L (1983): **Theory of Point Estimation**, John Wiley, NewYork.

4. Kale, B.K, (1999): **A First Course on Parametric Inference**, Narosa publishing House.

5. Cassella and Berger: **Statistical Inference**, Thompson, New Delhi.

**Core Course – XI** **DESIGN AND ANALYSIS OF EXPERIMENTS**

**Unit I**

Linear models- Estimability of linear parametric functions-Generalized Gauss-Markov theorem on linear estimation (BLUE) –Fixed, mixed and random effect models-ANOVA for one-way and two-way classified data – ANOCOVA for one-way and two-way classification with one concomitant variable.

**Unit II**

Introduction to designed experiments – ANOVA for CRD,RBD ,LSD and their relative efficiencies – Missing plot techniques for RBD and LSD with one (or) two missing observations – Need and scope of Split-plot design, Strip-plot design and their analysis – Split plot as main effects confounded factorial.

**Unit III**

General factorial experiments-analysis of symmetrical $2^n$ ($n \leq 5$),$3^n$ ($n \leq 3$), and asymmetrical (p x q) factorial – construction and analysis of confounded (complete and partial) symmetrical factorial – Fractional replication-symmetrical factorial ½ ($2^5$), ½ ($2^6$)

**Unit IV**

General block designs- concepts of connectedness, balancedness and orthogonali ty – BIBD and its parametric relations – Information (C)matrix and criteria for connectedness of block designs- Intra and Inter block analysis of BIBD –Youden square design and its intra block analysis.

**Unit V**

PBIBD with 'm' associate classes – classifications and parametric relations of PBIBD(2) – Intra block analysis of PBIBD(2) – Need and scope of response surface experiments- applications of experimental designs to quality management technique.

**Books for study and reference:**


1. Das, M.N and Giri.N.O. (1979): **Design and Analysis of Experiments,** Wiley Eastern.

2. John, P.W.M. (1987): **Statistical Design and Analysis of Experiments,** Mac Millan.

3. Joshi, D.D. (1987): **Linear Estimation and design of Experiments**, Wiley Eastern.

4. Kempthrone, O. (1966): **Design and Analysis of Experiments,** John Wiley.

5. Montgomery, D.C.(1991): **Design and Analysis of Experiments,** John Wiley.

6. Myers, A.H. (1971): **Response Surface Methodology**, Allyn and Bacon.

**Core Course XII** **PRACTICAL – III**

**(Based on papers: Statistical Estimation Theory**
**Statistical Quality Control , Design and Analysis of Experiments)**

The Maximum mark is 100 with 40marks for Internal involving Test and Record work.60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each with 20 marks .The Core Practical-III examination should be conducted at the end of IV Semester.

**Unit I**

(a) UMVUE of one parameter exponential family of distributions.
(b) ML estimation method.
(c) Method of moments.
(d) Minimum $\chi^2$ method.

**Unit II**

(a) Interval estimation based on Normal distribution.
(b) Interval estimation based on Student distribution.
(c) Interval estimation based on Chi-square distribution.
(d) Interval estimation based on F-distribution.

**Unit III**

(a) Statistical Analysis of missing plot technique in RBD with one or two Observations missing.
(b) Statistical Analysis of missing plot technique in LSD with one or two Observations missing.
(c) Statistical Analysis of covariance with concomitant variable in CRD Layout.
(d) Statistical analysis of covariance with one concomitant variable in RBD Layout.
(e) Statistical analysis of split plot design with RBD layout for both Main plot and sub plot.

**UNIT IV**

(a) Statistical analysis of $2^2$,$2^3$ and $3^2$ factorial experiments (without Con-founding)

(b) Statistical analysis of completely (totally) con founded designs ($2^2$,$2^3$ and $3^2$)

(c) Statistical analysis of partially confounded designs $2^2$,$2^3$ and $3^2$

(d) Statistical analysis of BIBD (intra block analysis only)

**Unit V**

(a) Construction of moving average control chart.
(b) Construction of EWMA control chart.
(c) Multivariate quality control charts ,control of means and control process variability (two variables only).
(d) Acceptance sampling plan for variables – construction of one sided, two sided procedure schemes, known and unknown sigma plans – O.C.curves.

**Core course XIII** **TESTING STATISTICAL HYPOTHESES**

**Unit I**

Test of Hypotheses. Concepts of testing hypotheses. Non-Randomized and randomized test- Critical region, Test function, Two types of errors, Level of significance, Size of the test, Power function, MP test, Neyman Pearson fundamental Lemma.

**Unit II**

UMP test, MLR property, UMP tests for one sided test in one parameter exponential and MLR family of distributions .Non existence of UMP test for simple hypotheses against two sided alternatives in one parameter exponential family.

**Unit III**

Generalized Neyman - Pearson fundamental Lemma (statement only).UMP test for two sided alternatives in one parameter exponential family .Unbiased test, UMP unbiased test, Similar test , Neyman Structure test, Likelihood Ratio test.

**UNIT IV**

Sequential Probability Ratio Test- Optimum properties of the SPRT- The Fundamental Identity of Sequential analysis, OC and ASN function of sequential plans. Simple examples

**UNIT V**

Non-parametric test ,Empirical distribution , Kolmogorov–Smirnov goodness of fit for one sample and two sample problems ,Sign test, Run test, Wilcoxon Signed- Rank test, Median test, Mann- Whitney U test.

**Books for study and reference:**

1. Santhakumaran,A., (2001): **Fundamentals of Testing Statistical Hypotheses**, Atlantic Publishers and Distributors, New Delhi.

2. Rohatgi ,V. (1988): **An Introduction to Probability and Mathematical statistics**, Wiley Eastern Ltd, New Delhi.

3. Rao,C.R., (1985): **Linear Statistical Inference and its Applications**, Wiley Eastern Ltd.

4.Lehman, E.L., (1986): **Testing Statistical Hypotheses**, John Wiley and sons.

5. Kala, B.K., (1999): **A First course on parametric inference**, Narosa publishing house.

6. Casella and Berger, **Statistical inference**, Thompson, New Delhi.

**Core Course - XIV** **PRACTICAL – IV**

**(Based on papers: Testing Statistical Hypotheses and Operations Research)**

The Maximum marks are 100 with 40marks for Internal involving Test and Record work.60 Marks for the University examination. The candidate should attend 3 questions out of 5 questions each with 20 marks .The Core Practical-IV examination should be conducted at the end of IV Semester.

**Unit I**

(a) Most powerful test –Binomial, Normal, Exponential.
(b) Uniformly most powerful test-One sided –Normal, Exponential, and two sided Bernoulli.
(c) Uniformly Most Powerful Unbiased Test- Binomial, Normal, Exponential.

**Unit II**

Sequential Probability Ratio Test (SPRT)
(a) Bernoulli.
(b) Normal
(c) Exponential

**Unit III**

Nonparametric tests.
(a) Kolmogorov -Smirnov test for one sample and two samples.
(b) Sign test
(c) Run test
(d) Wilcoxon Signed-Rank test
(e) Median test
(f) Mann-Whitney U test.

**Unit IV**

(a) Two person zero sum games.

(b)Queuing theory :

**Models**

(1) (M/M/1): ($\infty$ /GD)
(2) (M/M/1): (N /GD)
(3) (M/M/C): ($\infty$ /GD)
(4) (M/M/C): (N/GD)

**Unit V**

(a)Integer programming problem:

(1)Pure and Mixed.
(2) Gomery's cutting plane method.

(b)Quadratic Programming:

(1) Wolfe's modified simplex method
(2) Beale's method.

**Core Course -XV** **PROJECT WORK**

Project/Dissertation work shall be carried out under the supervisor of a Faculty member on the recommendation of the Head of the Department. **Three copies** of the Project report should be submitted at least two weeks before the last working day of the fourth semester. The Marks for the Project work is 100 and the components are:

**Internal Assessments: : 40 Marks**
**(For two reviews 20+20 = 40)**

**Evaluation of Project report by External Examiner and Supervisor : 40 Marks**

**Viva-Voce by External Examiner and Supervisor : 20 Marks**

The Evaluation of the Project will be based on Project Report and a VIVA-VOCE examination to be conducted by the Supervisor and an External Examiner.

**Elective - I** **RELIABILITY THEORY**

**Unit I**

Reliability: Definition-applications- components and systems-reliability function –Cumulative distribution function-failure rate function-hazard rate function-reliability in terms of hazard rate and failure rate density-Bath tub curve-conditional reliability-Reliability measures: mean time to failure, variance of failure distribution, median time to failure and mode life to failure. Simple problems.

**Unit II**

Life time distributions: Exponential failure model-derivation- properties-estimation of mean life with complete samples-reliability estimation-UMVUE estimators-Two parameter exponential model -estimation of mean life and reliability estimation with complete samples.

**Unit III**

Two parameter gamma and two parameter weibull distributions-estimation of parameters and reliability estimation with complete samples by MLE method and method of moments- reparametrization of weibull distributions.

**Unit IV**

System reliability: series, parallel, parallel-series and series-parallel configurations. k out of n systems. Two component system reliability by markov analysis.. System of components- Coherent structure and their representation in terms of paths and cuts. Modules of coherent system. Simple problems.

**Unit IV**

Reliability of coherent systems –reliability of independent components-association of random variables-bounds on system reliability – improved bounds on system reliability under modular decomposition. Shape of the reliability function.

**Books for study and reference:**

1.Charles E.Ebling(2000): **An Introduction to Reliability and mainatability engineering.** Tata MC Graw Hill, New Delhi. (**For Unit-I**)
2.Sinha,S.K., and Kale,S.K.,(1980): **Life Testing and Reliability Estimation**,Wiley Eastern (**For Units II and III**)
3.Barlow,R.E. and Proschen,F.(1975): **Statistical Theory of Reliability and Life testing**, Halt, Reinhart and Winston Inc.(**For Units IV and V**).
4.Balagurusamy.E :**Reliability Engineering**, Tata McGraw Hill.
5.Bain,L.J and Engelhardt(1991): **Statistical analysis of Reliability and life testing Models,** Marrcel Deckker.
6. Veerarajan,T(2003): **Probability ,Statistics and Random Processes**, Tat McGraw Hill, New Delhi.

**Elective –II** **STATISTICAL QUALITY CONTROL**

**Unit I**

Quality improvement in Modern Business Environment. The meaning of quality improvement. The link between quality improvement and productivity. Quality costs: prevention cost, appraisal costs, internal failure costs, external failure costs. Methods of quality improvement. Total Quality Management (Basic concepts only).

**Unit II**

Statistical process control: Moving average control chart – EWMA control chart – Cusum control chart –two sided and one sided procedures – V mask technique - Tabular

Cusum and decision interval. Economic design of $\bar{X}$ –chart – Single assignable cost model only.

**Unit III**

Multivariate quality control charts-control of means and process variability. Acceptance sampling plan for variables. Single sample- advantages and disadvantages – One sided and two sided specifications-known and unknown sigma.

**Unit I V**

Continuous sampling plans – CSP-1, CSP-2 and CSP-3. Statement of their properties only. Process capability indices: $C_p$ , $C_{pk}$ ,$C_{pc}$ and $C_{pm}$. Quality Circle.
ISO standards 9000, 9001, 9002.

**Unit V**

Modified control chart ($\bar{X}$ –chart ) and Acceptance control charts. Statistical process control with Auto correlated data: Sources and effects of Auto correlation in process data. Model-Based approaches and Model-Free approach.

**Books for study and reference:**

1. Montgomery, D.C. (1985): **Introduction to Statistical Quality Control,** John Wiley

2. Duncan, A.J. (1986): **Quality Control and Industrial Statistics**, Irwin Homewood

3.Grant, E.L. and Leavenworth.R.S.(1980): **Statistical Quality Control,** McGraw Hill

**Elective - III** **OPERATIONS RESEARCH**

**Unit I**

Game theory-optimum solution of Two-person zero sum game-solution of pure and mixed strategy game- Decision Environment- Decision making under certainty- Decision making under risk –Expected value criterion –Decision making under uncertainty.

**Unit II**

Queuing Models: Specifications and effectiveness measures –steady state solutions of M/M/1 and M/M/C with finite and infinite capacity models –length and waiting time of M/G/1 and G/M/1 queue –Pollazock Khintchine formula. Steady state Solution of $M/E_k/1$ queues.

**Unit III**

Integer programming problem-all integer or pure integer programming- mixed integer programming –Gomory's cutting plane method-Branch and Bound method.

**Unit IV**

Non linear programming problem-Unconstrained optimization-Single variable function-multivariable function-Constrained multivariable optimization with equality and inequality constraints. Lagrangian method – Khun-Tucker conditions. Quadratic programming problem(QPP)- Wolfe's modified Simplex method –Beale's method.

**Unit V**

Dynamic programming problem –characteristics of DPP –Bellman's principles of optimality- General algorithm –Stage coach problem-Cargo loading model –Work force size model-Investment model – LPP as DPP.

**Books for study and Reference:**

1. Taha, H.A. (1999): **Operational Research: An Introduction**, Prentice Hall.

2. Sharma, J.K.(2002): **Operations research**, Mac Millan.

3. Rao, S.S. (1992): **Optimization Theory &Applications**, Wiley, New Delhi.

4. Medhi.J.(1982): **Stochastic process**, Wiley eastern.

**Elective - IV** **STOCHASTIC PROCESSES**

**Unit I**

Introduction to stochastic process (SP) – classification of SP according to state space and time domain. countable state markov chain (MC). Chapman-kolmogorov equations. Calculation of 'n' step transition probability.

**Unit II**

Discrete state space – continuous time MC. Kolmogorov differential equations. Poisson process ,birth and death process .Application to queues and storage problem. Random walk – Wiener process as a limit of random walk, first passage time.

**Unit III**

Markov process – continuous time and continuous state space - time homogenous markov process – kolmogorov's equation. Diffusion process with Wiener process.

**Unit IV**

Stationary process and time series- wide sense and strict sense stationary process – moving average and auto regressive process. Covariance function - Bochner's function (statement), Khintchine's representation of wide sense stationary process, spectral decomposition for weakly stationary process.

**Unit V**

Renewal theory – renewal function and its properties .Elementary and key renewal theorems.

**Books for study and Reference**


1. Medhi.J. (1982): **Stochastic process**, Wiley Eastern.

2. Bhat, B.R. (2000):**Stochastic models :Analysis and Applications**, New age International, India.

3.Karlin and Taylor H.M, (1975):**First course in Stochastic Process**-Vol I academic Press.

4. Prabhu, N.U. (1965):**Stochastic process**, Macmillan ,New York.

5.Feller,W. (1968):**Introduction to Probability and Applications**, Wiley Eastern Company

6. Ross, S.M. (1983) :**Stochastic Process,** Wiley, New York.

**Elective-V** **ACTURIAL STATISTICS**

**Unit – I**

Utility Theory –Insurance and utility theory. Models for individual claims and their sums- Survival function- Curtate future life time –Force of mortality.

**Unit – II**

Life tables and its relation with survival function- examples-assumptions for fractional ages –some analytical laws of mortality. Select and ultimate tables.

**Unit – III**

Multiple life function- joint life and lost survivor status- Insurance and annuity benefits through multiple function evaluation for special mortality laws.

**Unit – IV**

Multiple decrement models –deterministic and random survivorship group-associated single decrement tables-central rate of multiple decrement – net single premium and their numerical evaluation.

**Unit – V**

Distribution of aggregate claims- compound Poisson distribution and its applications.

**Books for study and Reference**

1. Bowers,N.L, Gerber. H.U, Hickman. J.C, Jones. D.A and Nesbitt .C.J(1986):**Actuarial Mathematics**, Society of Actuarial, Ithaca, Illinois, USA (Second edition).

2.Neill,A(1977):**Life Contingencies**, Heinemann.

**Elective-VI** **APPLIED REGRESSION ANALYSIS**

**Unit – I**

Multiple Linear Regression. Estimation of Model parameters. Least square estimation of the regression coefficients-properties of least square estimators. Maximum likelihood estimation-Tests for the significance of regression- test on individual regression coefficients –Confidence interval on the regression coefficients- Confidence interval estimation of mean response-Prediction –Standard regression coefficients-Unit normal scaling-Unit length scaling.

**Unit – II**

Residual analysis. Definition and properties of residuals-methods of scaling residuals-Residual plots- PRESS statistic- formal test for lack of fit. Variance -Stabilizing transformation-transformations to linearize models-Generalized and weighted least squares. Indicator variables-concept and use.

**Unit – III**

Model building problem-variable selection-Stepwise regression methods. Multicollinearity - sources and effects of multicollinearity –Diagnostics and methods for detecting multicollinearity.

**Unit – IV**

Polynomial regression. Polynomial model in one variable. Piecewise Polynomial fitting (Splines) - Non parametric regression. Kernel regression –Locally Weighted regression. Polynomial model in two or more variables.

Non-linear regression-nonlinear least square-transformation to linear model-parameter estimation.

**Unit – V**

Generalized Linear Models (GLM). Logistic regression-Estimation of parameters in logistic regression models-Interpretation of parameters in logistic regression models. Poisson regression-GLM-link function and linear prediction- parameter estimation in GLM.

**Books for study and reference:**

1. Montgomery, D.C., Peck E.A, Vining, G.G. (2003): **Introduction to Linear regression Analysis,** John Wiley &sons, Inc, New York.(chapters 1,2,3,8,9,11).

2. Draper, N.R. and Smith, H. (1998): **Applied regression Analysis,** John Wiley

**Elective-VII** **STATISTICALCOMPUTING**

## (Java Programming)

**Unit I**

Object Oriented Programming (OOP): Basic concepts- benefits and application of OOP-History of Java-features – Java environment-API. Program structure-statements-tokens-Implementing a java program- Java Virtual Machine-Command line arguments Constants-variables-data types-operators and expressions.

**Unit II**

Control statements: if and its variants- switch statement-?operator. Loops: while, do and for statements. Jumps in loops and labeled loops.

**Unit III**

Classes-adding variable-adding methods-creating objects-accessing class members-constructors-methods overloading-static members-nesting of methods-Inheritance and its types-overriding methods-final variable, methods and classes-abstract methods and classes. Arrays-Strings-Vectors.

**Unit IV**

Interfaces-defining, extending and implementing interfaces. Packages- creating accessing and using a package. Type of errors- Exceptions- try, catch and finally statements. Applets-types - building applet code-applet life cycle-creating an executable applet.

**Unit V**

Writing programs In Java: Matrix operations-addition, product and inverse. Arranging observations in increasing and decreasing order. Computation of mean, median, variance, skewness and kurtosis of raw data. t-test. Chi-square test for independence of attributes. ANOVA for one-way and two-way classifications.

**Books for study and reference:**

1. Balagurusamy,E.(2000): **Programming with JAVA**, Tata McGraw Hill, New Delhi.

2. Hubbard,R.(1999): **Theory and Problems of Programming with JAVA,** Schaum's Outline Series, McGraw Hill**, New York.**

3. Naughton, Patrick and Herbert Schmidt. (1996):**Java: The Complete Reference**, Osborne McGraw Hill.

**Elective-VIII** **ECONOMETRICS**

**Unit I**

Nature and scope of Econometrics: Production and cost analysis -price and income Elasticity of demand. Price Elasticity and supply –Torquivisits model of demand Inferior goods-Models building –Bias construction of models.

**Unit II**

The General Linear Model (GLM) and its extension. Ordinary Least square (OLS) estimation and prediction .Generalized Least square (GLS) estimation and prediction and their properties – problem of hetroscedasticity and multicollinearity pure and mixed estimation .Grouping of observations and of equations.

**UnitIII**

Single equation linear model –dynamic case; Autocorrelation and its consequences Testing for Autocorrelation; Theil's BLUS procedure .Estimation and Prediction Estimation of parameters of a linear model with auto correlated disturbances and distributed lag models –Errors in variable models.

**Unit IV**

Simultaneous linear equation model – Examples. Identification problem .Estimation Using LIM, Instrumental Variables. 2 –SLS methods.

**Unit V**

K class estimators; Full information Maximum Likelihood methods .3-SLS estimators- Simultaneous LSE and integrated LST methods .Monte Carlo studies and simulation –Concepts of structural change –Tests of structural change

**Books for study and reference:**

1.Johnston (1984): **Econometrics models (3rd edition)**, McGraw Hill, Tokyo.

2.Intrulligator ,M.D. (1980): **Econometric models :- Techniques and Applications**, Prentice Hall of India.

3.Walters, A. (1970): **An introduction to Econometrics** , McMillan & Co.

4. Gold Berger (1964): **Econometric theory**, Wiley.

5. Allen RGD. (1965): **Mathematical Economics**, Mc Millan.

## Extra Disciplinary Course -I Elements of Operations Research

**Unit I**

Operations Research: Introduction-Origin and development of O.R-Definition and Applications of O.R. – Models in O.R.-classification of models-advantages and limitations of models. General solution for O.R models. Methodology of O.R. Linear programming problem. Formulation of LPP.

**Unit II**

Graphical method of solving LPP. Simplex method –Big M method. Concept of duality in LPP. Formulation of dual problems only.

**Unit III**

Transportation problems: Finding initial basic feasible solution-test for optimality by MODI method. Assignment Problem: Hungarian method of solving A.P. Maximization in Assignment problem.

**Unit IV**

Sequencing: problem of sequencing- basic terms used in sequencing- processing 'n' jobs through two machines- processing 'n' jobs through 'k' machines- processing two jobs through 'k' machines.

**Unit V**

Game Theory: Definition-types of games- The Maximin-Minimax principle. Games without saddle points (mixed strategies)-graphical method of 2 x n and m x 2 games- Dominance property.

**Books for study and Reference:**


1. Kanti Swarup (2007): **Operations Research,** Sultan Chand & Sons, New Delhi.

2. Sharma, J.K. (2002): **Operations Research**, Mac Millan.

3. Kalavathy.S. (2002): **Operations Research,** Vikas Publishing House, New Delhi.

## Extra Disciplinary Course –II Statistical Methods

**Unit I**

Definition of Statistics and its applications in various disciplines. Collection of data. Classification, tabulation and graphical representation of data. Construction of univariate and bivariate frequency distributions. Charts and Diagrams: bar diagram, Pie diagram. Histogram, frequency and cumulative frequency curves.

**Unit II**

Measures of central tendency: concept and uses. Mean, Median, Mode, Geometric Mean and Harmonic mean.

Measures of variation: concept and uses. Range, Quartile deviation, standard deviation and coefficient of variation. Measures of Skewness

**Unit III**

Census and Sample surveys. Concept of sample and sampling-.Principles of sampling. Advantages and limitations of sampling. Random sampling: simple random sampling, Stratified random sampling. Systematic sampling and Cluster sampling.Non-random sampling: Quota sampling, convenience and Judgment sampling,snow ball sampling.

**Unit IV**

Simple linear correlation: meaning and its uses. Scatter diagram-Karl pearson product moment correlation-rank correlation.

Simple linear regression: meaning and its uses. Difference between correlation and regression. Regression equations.

**Unit V**

Definition and utility of Time series analysis. Components of Time series.

Measurement of Trend: Method of moving averages and Method of Least Squares.

Measurement of Seasonal variations: Method of Simple averages and Method of Link relatives.

**Books for study and Reference:**


1. Gupta. S.P (2007): **Statistical Methods**, Sultan Chand & Sons, New Delhi

2. Agarwal.D.R. (2003): **Quantitative Methods**, Virinda Publications, New Delhi.

3. Richard Levin. (2000); **Statistics for Management**, Prentice Hall, India


**(For the candidates admitted from 2008-2009)**

# MODEL QUESTION PAPER

**M.Sc, DEGREE EXAMINATION, November 2008**

**First Semester**

**Branch II -Statistics**

**Core V - SAMPLING THEORY AND METHODS**

**Time :Three hours** **Maximum:75 marks**

**PART A - ( 5 x 5 = 25 marks )**

**Answer ALL questions.**

**All questions carry equal marks.**

1. (a) Mention the important steps involved in drafting a questionnaire.

Or

(b) What is meant by non-response? Write down its types.

2. (a) In SRSWOR, show that the sample mean square is an unbiased estimate of the population mean square

Or

(b) Explain circular systematic sampling.

3. (a) Explain separate and combined regression estimators.

Or

(b) Define multivariate ratio estimator.

4. (a) Explain Lahiri's method of selecting sample under PPSWR schme.

Or

(b) Derive Horwitz-Thompson estimator for population total.

5. (a)Describe the sub sampling procedure.

Or

(b)In double sampling for stratification, show that the sample mean is an unbiased estimate if the population mean

**PART B - (5 x 10 = 50 marks)**

**Answer ALL questions.**

**All questions carry equal marks.**

6.(a) Explain the principal steps involved in sample survey?

Or

(b) Derive Warner's model in randomized response technique.

7.(a) If f.p.c is ignored, then show that

$V_{opt} < V_{prop} < V_{rand}$

Or

(b) Compare systematic sampling with stratified and simple random sampling when the population consists of linear trend.

8. (a)Define ratio estimator. Derive the variance of the ratio estimator and also obtain its relative bias.

Or

(b) Obtain an unbiased estimate of population mean and its variance in cluster sampling.

9. (a) Define Desraj's ordered estimator. Also derive the expression for the variance of the estimate of the population total.

Or

(b)In the case of pps sampling with replacement, obtain an unbiased estimator of the population total and variance of the estimator.

10. (a)Suggest an estimator for an estimator in two stage sampling and also derive its variance.

Or

(b) Discuss double sampling for stratification and derive the standard error of estimate.