

**DEPARTMENT OF STATISTICS
CH. CHARAN SINGH UNIVERSITY, MEERUT**

DETAILED COURSES OF STUDY For M.Phil. (Statistics)

(A) THEORY COURSES

Course No.:T-101 Course Title: Advanced Probability Theory

Need of the Course- Probability theory plays a key role in the study of phenomena in the fields such as engineering, managerial science, physical and social sciences, finance and insurance sectors. Therefore, it is necessary to have the knowledge of the convergence of sequences, laws of large numbers and other advanced probability theorems which are very useful in analyzing the long term behavior of the processes.

Objective of the Course- The aim is to equip the students with the knowledge of the fundamentals of the random variables and their distributions, the axioms of probability theory, the convergence and laws of sequences of random variables.

Learning Outcomes- The students should be able to apply the knowledge and understanding of the measure theory approach of the probability to minimize the risk in decision making.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|------------------------|
| Modes of Convergence: convergence in probability, convergence in law, convergence almost surely, convergence in rth mean, Slutsky's lemma, Borel-Cantelli lemma. | 20 |
| Moment inequalities: Markov, Chebyshev, Jensen, Kolmogorov, Basic, Liapunov, Holder. | 10 |
| Law of large numbers: Khinchine's WLLN, necessary and sufficient conditions for WLLN, Kolmogorov's SLLN, tail equivalence lemma, three-series criterion. | 15 |
| Definition, properties of the integral, monotone convergence theorem, indefinite integrals, uniform integrability, mean convergence. | 10 |
| Marcinkiewicz-Zygmund inequality, dominated ergodic theorem. | 05 |

Total No. of Lectures – 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. B.R.Bhatt : Modern Probability Theory
2. V.K.Rohatgi : An Introduction to Probability Theory and Mathematical Statistics

3. K.L.Chung : Course in Probability Theory
4. P.Billingsley : Probability and Measure
5. Laha and Rohatgi : Probability Theory
6. Tucker : A Graduate Course in Probability

Course No.: T-102 **Course Title: Statistical Inference
and Distributions**

Need of the Course- After studying the population parameters, it is essential to test their significance for which one is to take deep knowledge of various parametric and non-parametric tests. More so, for parametric studies some of the important discrete and continuous distributions with their characterization play their significant role for the complete knowledge of Inference.

Objective of the Course- The main objective of the course is to provide deep & advance knowledge of parametric and non-parametric tests and useful distributions involved in testing of hypotheses with their practical applicability.

Learning Outcomes- The knowledge of the course contents will be much useful in advanced research pertaining to theoretical and applied research in order to draw important conclusions regarding the population parameters.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|-----------------|
| Hypothesis Testing: Optimum regions and sufficient statistics, similar tests, test with Neyman structure, Randomised tests. Monotonicity, consistency and Invariant properties of the tests. Elements of decision theory, Hypothesis testing as a decision problem. Bayes and Minimax tests. | 15 |
| Non Parametric Methods: Run test for randomness, sign test for location, median, Wilcoxon, Mann-whitney tests and Kolmogorov–Smirnov test (with distribution of the test statistics involved) for the two sample problem. Tests for goodness of fit. Distribution free confidence intervals for quantiles and confidence bands for distribution functions. | 15 |
| Statistical Distributions: Detailed Study with Examples and applications of negative hypergeometric bivariate and multivariate hypergeometric, negative multinomial, Polya-Eggenberger, Inverse Polya-Eggenberger, multivariate Polya-Eggenberger. Their ascending and descending factorial moments, Marginal and Conditional distributions, compound and limiting distributions. | 20 |
| Generalized Beta distribution, bivariate Beta, bivariate inverted Beta, bivariate Gamma and bivariate F distributions. Non-Central distributions of Beta, Chi-Square, t and F. Doubly non-central t, F and Beta distribution. | 10 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Lehmann, E.L : Testing Statistical Hypothesis.
2. Rao, C.R : Linear Statistical Inference & Its Application.
3. Mood, A.M. Graybill, F.A. Boes, D.C : Introduction to the theory of Statistics.
4. Rohtagi, V.K. : An Introduction to Probability Theory and Mathematical Statistics
5. Ghosh, B.K. : Sequential Tests And Sequential Hypothesis.
6. Ferguson, T.S. : Mathematical Statistics- A Decision Theoretic Approach.
7. Gibbons, J.D. : Non-Parametric Methods In Statistics.
8. Goon, A.M., Gupta, M.K. : An outline Of Statistical Theory Vol.I and Das Gupta, B.
9. Johnston, N.L. and Kotz, S.: Distributions In Statistics.
 - (i) Discrete Distributions.
 - (ii) Continuous Univariate Distributions I.
 - (iii) Continuous Univariate Distributions II.
 - (iv) Continuous Multivariate Distributions.
10. Wilks, S.S : Mathematical Statistics.

Course No.: T-103

Course Title: Sequential Estimation

Need of the Course- Sequential estimation procedures are generally needed when-

- The sample size is not fixed in advance of the experiment.
- Risk is to be minimized with limited resources.
- The consumer and producer fix their risks in advance.

Objective of the Course- The objective of the course is to provide the fundamental knowledge of two-stage sequential procedure, fixed sample size procedures with fixed-width confidence interval and minimum and bounded risks especially in the case of normal population.

Learning Outcomes- The students should be able to apply the theory and applications of sequential procedures to the real data.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|-----------------|
| Failure of the fixed sample size procedures to deal with the problems of fixed-width confidence interval and minimum risk and bounded risk (under a Family of loss functions) point estimation of a normal mean when the variance is unknown. Stein's two-stage procedure to construct fixed-width confidence interval for the mean of normal population. Drawbacks of Stein's two-stage procedure. Purely sequential procedure to construct fixed width confidence interval for the mean of a normal population-its asymptotic risk efficiency and consistency. Sequential minimum risk point estimation of the mean of a normal population-its asymptotic efficiency and bounded regret. Cramer-Rao inequality for sequential estimation. Theory of the second-order approximations. | 60 |

Total No. of Lectures - 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Wald, A. : Sequential Analysis.
2. Wetherill, G.B : Sequential Methods In Statistics.
3. Ghosh, B.K. : Sequential Tests Of Statistical Hypothesis.
4. Rao, C.R. : Linear Statistical Inference and Its Applications
5. Zacks, S. : The Theory Of Statistical Inference.
6. Lehmann, E.L. : Testing Statistical Hypothesis
7. Rohatgi, V.K : An Introduction to Probability theory and Mathematical Statistics
8. Goon, A.M, Gupta, M.K. : An outline of Statistical Theory Vol.II. and Das Gupta

Course No.: T-104

Course Title: Stochastic Process

Need of the Course- The mathematical description of a random phenomenon as it changes in time is a stochastic process. Since the last century there has been greater realization that stochastic (or non-deterministic) models are more realistic than deterministic models in many situations, the knowledge of the course contents is essential.

Objective of the Course- Keeping in view the need of the course, the aim is to study the different types of stochastic process, random walk, renewal theory with their wide applicability in social science, economics and management sciences.

Learning Outcomes- The knowledge of the course can be applied in various diverse fields such as operations research, finance and insurance sectors, banking, planning & forecasting.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|-----------------|
| Markov Chain, Chapman Kolmogorov equation, classification of states, criteria for ergodic, persistent null and transient states, stationary distributions, limit theorems on transient and persistent null states, birth and death processes Kolmogorov forward and backward equations, Poisson process, Generalized, filtered and compound Poisson process, Wiener processes, Gaussian processes, mean function and covariance, Kernal strictly stationary and covariance stationary processes, processes with independent increments, continuity, integrability and differentiability of a process (in mean), Ergodic theorem, Harmonic Analysis, Renewal equations. | 60 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Cox, D.R. and Miller, H.D.: The Theory Of Stochastic Processes.
2. Deeb, J.L. : Stochastic Processes.
3. Srinivasan, S.K. and Menata, K.K. : Stochastic Processes.
4. Bartlett, M.S. : Introduction to Stochastic Processes.
5. Prabhu, N.U. : Stochastic Processes.

Course No.: T-105 Course Title: Advanced Designs

Need of the Course- Experimental designs are those by which the knowledge of various statistical topics can be applied in agriculture field for improving the crop-plants through genetic-techniques.

Objective of the Course- The objective of the course is to provide the knowledge of the construction and analysis of various applied designs such as BIBD, Factorial, Different types of L.S.D. etc.

Learning Outcomes- Keeping the knowledge of the course, one can apply the techniques of advanced design in Biological and Agriculture research in order to see the significant effect of different new drugs/treatments.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|-----------------|
| Constructions: Elementary Theory of groups, Elements of projective and Euclidean Geometries, Galois, Construction of - (i) Mutually orthogonal Latin squares.(ii)Hyper Graeco Latin Squares (iii)Incomplete Block Designs (Balanced and Partially Balanced)(iv)Totally and partially Confounded symmetric factorial designs. | 35 |
| Analysis :Analysis of factorial design (2×4 , 3×3 , 3^2) Square and rectangular lattice designs,partially balanced incomplete block designs with recovery of interblock information. | 20 |
| Response Surfaces: Fractional replication in case of 2^n and 3^{TM} types, Analysis of group experiments. | 05 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Levi, F.W : Algebra Vol.I
2. Mann, H.B. : Analysis and Design of Experiments.(Dover Publication Inc.,New York).
3. Cockran, W.G.and Cox, G.M : Experimental Designs (Asia Publishing House, Bombay)
4. Kelmphrone, O. : The Design and Analysis of Experiments(John Wiley & Sons)

Course No.:T-106

**Course Title: Computer
Programming in FORTRAN Language.**

Need of the Course- In the modern age of computing, Statistician uses computers for large and fast calculations. The advanced knowledge of computers and a scientific programming language is a must for a student of Statistics.

Objective of the Course- The objective of this course is to introduce a student with basic know how of a computer system and to train him in the most popular scientific language FORTRAN.

Learning Outcomes- After this course a student will be fully equipped with the techniques of developing his own computer programmes for most of the mathematical as well as Statistical methods.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|------------------------|
| Basic Computer Structure :Overview Of Computer System, Memory, C.P.U, I/O Units, Higher and Lower Levels Computer Languages. Basic Concepts of Computer Softwares, Compilers, Operating Systems and Statistical Software packages. | 04 |
| Programming Methods : Problem analysis, Algorithms, Flow charts,Programming Desisgns, Criteria for a good programming method. | 04 |
| Fortran Programming Language : Basic features of Fortran Language, Constants and Variables, Arithmetic and logical operators, Arithmetic and logical expressions, input-output statements, Control statement, Branching and looping, Do statement, Formal specifications, Arrays, User and system defined functions, Subroutine subprograms. | 12 |
| Fortran Programs For : (a) Statistical Methods : Measures of central tendency and Dispersion. Moments, Correlation, Regression, Curve fitting. Test of significance, t-test and Chi-Square test for given data. | 08 |
| (b) Matrix Algebra: Addition, Multiplication, Transpose, Determinant and Inverse of Matrices. Solution of system of Linear Equations. | 08 |
| (c) Numerical Analysis : Types of errors in computation, roots of algebric and transcendental equations by Bisection and Newton-Rapson methods. Difference table, Newton's forward, backward, Lagranges formulae for interpolation, Numerical integration, Trapezoidal, Simpson's 1/3 rd and 3/8 th rules, Weddle rule. | 08 |
| (d) Properties of Statistical Distributions: Calculating pmf and cdf of Uniform, Binomial, Poission, Normal, Cauchy, Gamma, Beta, Students't and Chi-square distributions, Generation of random numbers. | 08 |
| (e) Reliability Characteristics : Reliability, hazard rate, failure rate, MTSF, Series system, Parallel and k-out of m system. | 08 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED :

1. Raja Raman V. : Computer Programming in Fortran-77 Third Edition, Prentice Hall of India Pvt. Ltd. New Delhi.
2. Balagurusamy E. : Fortran for Beginners: Including Fortran-77, Tata Mc-Graw Hill Publishing Company Ltd. New Delhi.
3. Raja Raman V. : Computer Programming in Fortran-90 and 95, Prentice Hall of India Pvt. Ltd. New Delhi (1997).
4. Ram Kumar : Programming with Fortran-77, Tata Mc-Graw Hill Publishing Company Ltd. New Delhi (1995).
5. Raja Raman V. : Computer Oriented Numerical Methods, Printice Hall of India Pvt.Ltd. New Delhi.
6. Grover P.S. : Programming & Computing with Fortran-77/99.

Course No.: T-107

**Course Title: Computer
Programming in 'C' Language.**

Need of the Course- In the modern age of computing, Statistician uses computers for large and fast calculations. The advanced knowledge of computers and a scientific programming language is a must for a student of Statistics.

Objective of the Course- The objective of this course is to introduce a student with basic know how of a computer system and to train him in the middle level computer programming language 'C'.

Learning Outcomes- After this course a student will be fully equipped with the techniques of developing his own computer programmes for most of the mathematical as well as Statistical methods.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|--|------------------------|
| Basic Computer Structure : Overview Of Computer System, Memory, C.P.U, I/O Units, Higher and Lower Levels Computer Languages. Basic Concepts of Computer Softwares ,Compilers, Operating Systems and Statistical Software packages. | 04 |
| Programming Methods: Problem analysis, Algorithms, Flow charts, Programming Designs, Criteria for a good programming method. | 04 |
| C Programming Language : Basic features Of C Language, constants, Variables and data types, operators and expressions Arithmetic, relational and logical, input and output statements with their formats, decision making statements, branching and looping, Arrays, user and system defined functions, structures and pointers . | 12 |
| C Language Programs For : (a) Statistical Methods : Measures of central tendency and Dispersion. Moments, Correlation, Regression, Curve fitting. Test of significance, t-test and Chi-Square test for given data. | 08 |
| (b) Matrix Algebra: Addition, Multiplication, Transpose, Determinant and Inverse of Matrices. Solution of system of Linear Equations. | 08 |
| (c) Numerical Analysis : Types of errors in computation, roots of algebraic and transcendental equations by Bisection and Newton-Rapson methods. Difference table, Newton's forward, backward, Lagranges formulae for interpolation, Numerical integration, Trapezoidal, Simpson's 1/3 rd and 3/8 th rules, Weddle rule. | 08 |
| (d) Properties of Statistical Distributions: Calculating pmf and cdf of Uniform, Binomial, Poission, Normal, Cauchy, Gamma, Beta, Students' t and Chi-square distributions, Generation of random numbers from these distributions. | 08 |
| (e) Reliability Characteristics : Reliability, hazard rate, failure rate, MTSF, Series system, Parallel and k-out of m system. | 08 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Balagurusamy E. : Programming in ANSI C , Tata Mc-Graw Hill Publishing company,Ltd. New Delhi (1998)
2. Kanetkar Yashwant P. : Let us C , BPB Publications, New Delhi (1999)
3. Kernighan B.W and Ritchie Dennis M., : The C Programming Language, Prentice Hall of India Pvt Ltd. New Delhi (1997).
4. Raja Raman V. : Computer Programming In C, Prentice Hall of India Pvt. Ltd. New Delhi (1999)
5. Gottfried Byron S. : Programming with C, (Schaum's Outline) Tata Mc Graw Hill Publishing company Ltd. New Delhi (1999).

Course No.: T-108

**Course Title: Computer
Programming in C++ Language.**

Need of the Course- In the modern age of computing, Statistician uses computers for large and fast calculations. The advanced knowledge of computers and a scientific programming language is a must for a student of Statistics.

Objective of the Course- The objective of this course is to introduce a student with basic know how of a computer system and to train him in the object oriented programming language C++.

Learning Outcomes- After this course a student will be fully equipped with the techniques of developing his own computer programmes for most of the mathematical as well as Statistical methods.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|------------------------|
| Basic Computer Structure :Overview Of Computer System, Memory, C.P.U, I/O Units, Higher and Lower Levels Computer Languages. Basic Concepts of Computer Softwares ,Compilers, Operating System and Statistical Software packages. | 04 |
| Programming Methods : Problem analysis, Algorithms, Flow charts, Programming Designs, Criteria for a good programming method. | 04 |
| C++ Programming Language : Introduction and Biography of C++ Language, Procedural, Structural and Object Oriented Programming, C++ and Object Oriented Programming, Making a program, library files and header files, starting with C++, Variable and Constants, Some useful C++ statements, Decision Making and Branching, Decision Making and Looping, Arrays, User Defined Functions, Pointers ,Structures, Objects declared as classes, Encapsulation, data hiding, Inheritance, Polymorphism. | 12 |
| C++ Language Programs For : (a) Statistical Methods : Measures of central tendency and Dispersion. Moments, Correlation, Regression, Curve fitting. Test of significance, t-test and Chi-Square test for given data. | 08 |
| (b) Matrix Algebra: Addition, Multiplication, Transpose, Determinant and Inverse of Matrices. Solution of system of Linear Equations. | 08 |
| (c) Numerical Analysis : Types of errors in computation, roots of algebraic and transcendental equations by Bisection and Newton-Rapson methods. Difference table, Newton's forward, backward, Lagranges formulae for interpolation, Numerical integration, Trapezoidal, Simpson's 1/3 rd and 3/8 th rules, Weddle rule. | 08 |
| (d) Properties of Statistical Distributions: Calculating pmf and cdf of Uniform, Binomial, Poission, Normal, Cauchy, Gamma, Beta, Students't and Chi-square distributions, Generation of random numbers from these distributions. | 08 |
| (e) Reliability Characteristics : Reliability, hazard rate, failure rate, MTSF, Series system, Parallel and k-out of m system. | 08 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED :

1. Balagurusamy E. : Object Oriented Programming with C++, Tata Mc-Graw Hill Publishing Company Ltd. New Delhi (1999).
2. Kanetkar Yashwant P. : Let us C++ ,BPB Publications,New Delhi (1999).
3. Lafore Robert : Object oriented Programming in Turbo C++, Galgotia Publications Pvt. Ltd. New Delhi (2001).
4. Al Stevens : Teach Yourself C++, BPB Publications, New Delhi.

Course No.: T-109

**Course Title: Advanced Bayesian
Statistics & Reliability Theory**

Need of the Course- The science & Technology and the need of modern society are racing against each other. So, the industries are trying to introduce more and more automation. In view of above, systems are becoming complex and to examine the reliability of these systems one should have the knowledge of various reliability characteristics and methods of improving the reliability. Moreover, the inferential part is also essential in estimating the reliability and some other characteristics for which the knowledge of advanced Bayesian tools are need.

Objective of the Course- The objective of the course is two fold. Firstly, to equip the students with the knowledge of the basic reliability measuring tools, different system configurations, methods of reliability improvements with their practical aspects. Secondly to provide knowledge and understanding of applying advanced Bayesian tools for predicting and analyse the system reliability.

Learning Outcomes- Having the knowledge of this course, one will be able to use the techniques of improving and estimating the reliability in day to day real existing engineering systems.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|------------------------|
| (i)Advanced Bayesian Statistics:- An outline to Bayesian framework, Types of priors, Methods of obtaining priors, Types of loss functions, Computation of posterior distributions, Bayesian Computation, Bayesian CLT, Classical Monte Carlo Integration, Importance sampling, Accept-reject method(ARM). | 15 |
| Markov Chain and Monte Carlo (MCMC)-Methodology: Background, Metropolis Algorithm, Detailed Balance Equation, Metropolis-Hastings Algorithm, Gibbs Sampler, Finding the full conditionals, Empirical Bayes, HPD intervals, Codings in R-environment. | 15 |
| (ii) Reliability and Theory: Failure density, failure rate, reliability and its graphical representation, Pointwise and steady state availabilities, Interval availability and Interval reliability, Mean time to system failure(MSTF) and mean time between failures. Constant linearly increasing and non-linear increasing hazard models, Normal, gamma, lognormal and truncated normal failure laws, Expressions of reliability and MTSF in series structure, Parallel structure, k-out of n-structure, series parallel structure, parallel series structure and bridge configuration. Various kinds of active redundancies and standby redundancy and their reliability comparison. System maintenance and system repair under different repair disciplines, various types of priority redundant systems. Availability analysis of n-non identical unit series system with constant failure and repair rates by using Markov model. Analysis of two identical and non-identical unit parallel and standby systems with constant failure and constant/general repair rates by using supplementary variable technique and regenerative point technique, n-unit standby system with parallel repairs, two-unit standby systems with slow and imperfect switching devices Renewal function. | 30 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Hogg, MC Kean and Craig : Introduction to Mathematical Statistics, Pearson Prentice Hall
2. Robert, C.P. and Casella : Monte Carlo Statistical methods G. Springer, New york
3. Sheldon M. Ross : Introduction to probability models, Academic Press, New york
4. Balaguruswamy,E. : Reliability Engineering, Tata Mc Graw Hill.
5. Govil A.K. : Reliability Engineering,Tata Mc Graw Hill.
6. Rau, J.G. : Optimization and Probability in Systems Engineering, Van Nostrand Reinhold Company.

Course No.: T-110

Course Title: Survival Analysis

Need of the Course- The Statistical analysis of lifetime or survival time data has developed into an important topic for workers in many areas specially engineering, quality control and biomedical sciences.

Objective of the Course- The objective of this course is to provide lifetime distribution methodology to students for the estimation and testing of hypotheses regarding reliability characteristics of systems.

Learning Outcomes- After this course a student is expected to learn the modeling of lifetime data using various survival models, and to optimally estimate the reliability characteristics both by classical as well as Bayesian methods.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|------------------------|
| Basic concepts : Definition Of Reliability Function, Failure rate or hazard function, Mean residual life and their relationship, Life testing plans or censoring methods, Right and left censoring, Type I and II censoring with and without replacement, Random Censoring. | 08 |
| Some failure time distributions: One and two parameter exponential, Gamma, Weibull, the extreme value and normal probability models as used in the analysis of life time data and in problems related to the modeling Of aging or failure processes, some mixture models in a lifetime distribution. | 12 |
| Reliability Estimation Procedures: Estimation of Parameters and reliability function associated with various life time distributions and life testing plans, Various properties of these estimators, confidence intervals for parameters and reliability function. | 20 |
| Testing Of Hypothesis: Testing hypothesis regarding parameters and reliability function associated with various lifetime distributions, Testing problems as a basis of quality control. | 12 |
| Bayesian Techniques In Reliability Estimation: Bayes Estimator of parameters and reliability function associated with life time distributions. Their properties and comparison with classical estimators. | 08 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED :

1. Sinha, S.K. : Reliability and Life Testing, Wiley Eastern Ltd.,1986.
2. Lawless, J.F. : Statistical Models and Methods for Life Time, Data, Wiley, 1982.
3. Mann,N.,Schafer, E. : Methods for Statistical Analysis of
and Singpurwalla,N. Reliability and Life,Data, Wiley,1974.
4. Miller : Survival Analysis, Wiley
5. Nelson : Applied Life Data Analysis
6. Kapoor K.C. & Lamberson : Reliability In Engineering Design
L.R. John Wiley and Sons,New York
7. Martz, H.F. and Waller : "Bayesian Reliability Analysis"
R.A. John Wiley & Sons.
8. Dimitri, K. : "Reliability & Life Testing Handbook" Prentice Hall, New Jersey.

Course No.: T-111

Course Title: Biostatistics

Need of the Course- To know the genetic structure of populations and the forces that alter that structure, one should have the knowledge of deterministic and probabilistic models of random mating, generalized treatment of mutation, migration and selection, and plant genetics.

Objective of the Course- The course objectives are:

- To formulate probability models for the laws of genetic transmission.
- To identify and assess the impact of basic forces that changes the genetics of a population.

Learning Outcomes- The students will be able to analyze genetic data to estimate the forces of genetic change.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|-----------------|
| Structure of a Breeding Population, Genetic Correlation under dominance, deterministic models of random mating under chromosomes and chromatid segregation, Generalised treatment of Mutation, Migration and Selection. | 20 |
| Application's of Fisher's fundamental theorem of Natural Selection, Theory Of Inbreeding, sex linked gene, Path Coefficients, Homozygosity in Finite Populations, Stationary distributions Of genes, Haploid and Diploid Models, Diffusion models in Genetics, Estimation of Components Of variation, Detection and estimation of Epistatic interaction and linkage in heredity, Chromosome mapping, Plant Genetics, Estimation of Gene frequencies in different blood group systems. | 40 |

Total No. of Lectures - 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED.

1. Johnson, E. : Probability Models In Genetics.
2. Meran, P.P. : Statistical Process In Heredity.
3. Li, C.C : Population Genetics.
4. Baily : Genetics.
5. Kempthorne, O. : Statistical Genetics.

Course No.: T-112

Course Title: Econometrics

Need of the Course- One needs to develop and apply statistical methods to the study of economic policies. Econometrics combines economic theory with statistics to analyse and test economic relationships.

Objective of the Course- The course aims to building of econometric models and various functions for economic analysis and future forecasting.

Learning Outcomes- After studying this course one learns to develop models for economic forecasting both from micro as well as macro economics point of view.

Details of the syllabus and lecture division:

| Contents of the Course | No. of Lectures |
|---|------------------------|
| Objectives behind building of econometric models, contributions of economic analysis to design of models and policy classification of models, micro and macro, closed and open, static and dynamic etc. | 15 |
| Demand Analysis, Derivation of demand curves from an axiomatic framework, general restrictions on parameters of a demand relationship, demand system, linear expenditure systems and addilog functions, specification and estimation. | 15 |
| Supply, Production function-Cobb-Douglas and CES functions, cost functions, estimation. | 15 |
| Lacotief input-output analysis. | 05 |
| Macro models, Keynesian model, multiplier-accelerator, macro-econometric model-Klein-Goldberger Econometric Model for the U.S.Economy. | 10 |

Total No. of Lectures- 60

Teaching Method – The teacher in his/her lecture initially will revise the contents of previous lecture and then he will draw the outlines of new contents of today's lecture. Thereafter he/she will explain in detail one by one the contents of the today's outlines. Finally he/she will make a quick revision of today's new contents taught.

Home Assignments, Quizzes, Surprise Class Tests- The continuing evaluation process through home assignments, quizzes, and surprise tests will be done by the concerned teacher teaching that course at regular interval of time.

BOOKS RECOMMENDED:

1. Tinburger, J. : Economic Policy, Principles and Design Chs.1 and 2.
2. Baumel, W.J. : Economic Theory and Operations Analysis.
3. Henderson, R.E. and Quandt, J.M. : Micro-Economic Theory, A Mathematical Approach.
4. Louis Phlips : Applied Consumption Analysis.
5. Kelvin Lancaster : Mathematical Economics.
6. Dorfman, Samuelson and Solow : Linear Programming & Economic Analysis.
7. Allen, R.G.D. : Macro-Economic Theory.
8. Klein and Goldberger : An Econometric Model for the U.S Economy.