MANGALORE UNIVERSITY

Scheme of Examination and Syllabus for

Ph.D Programme in Statistics

DEPARTMENT OF POST-GRADUATE STUDIES AND RESEARCH IN STATISTICS
MANGALAGANGOTHRI-574 199
2011

Proposed Syllabus of papers prescribed for the course work in Ph.D. Programme in Statistics

The present syllabus of Ph. D. course work was prepared and implemented during 2011. There was a need to revise the Syllabus to accommodate new research areas. A draft syllabus was placed before the PG board of studies. PG board of Studies in Statistics thoroughly discussed and modified the draft syllabus. The syllabus was prepared as per the regulations of Ph. D. Programme adapted by Mangalore University. The PGBOS in Statistics has drafted and finalized the syllabi for the following papers:

Paper I: Research Methodology

Paper II: Probability and Statistical Inference

Paper III: Theory paper related to the area of specialization

The papers I & II will be common to all candidates enrolled for the Ph.D. Programme. Syllabus of the third paper is related to the area of specialization (area of research). Accordingly, the syllabi for the following papers have been prepared. Paper III is opted by the doctoral candidate from the following.

a) Econometrics

b) Inventory Models

c) Financial Models

d) Financial Time Series

e) Stochastic Models and Operations Research

f) Statistical Computing

The content of study/review and the preparation of research proposal, which forms the structure of Paper IV, shall be designed and supervised by the respective guides.

The mode of internal assessment includes tests, seminars, assignments review works etc. The scheme of evaluation of the course work shall be according to the regulations governing the Ph.D. Programme

Code	Name	Hours of Instruction Per week	Duration of the exam(Hrs)	Marks			
				IA	Theory	Total	Credits
Paper 1	Research Methodology	4	3	30	70	100	04
Paper II	Probability and Statistical Inference	4	3	30	70	100	04
Paper III	Theory paper related to the area of specialization	4	3	30	70	100	04
Paper IV	Literature Review and Proposal	16	-	-	-	200	08
Total						**500**	**20**

Programme Outcomes (POs):

PO 1: Introduce the overall methodological approach for caring out the research.
PO 2: Indicate how the approach fits the overall research design.
PO 3: Provide background and a rationale for methodologies that are unfamiliar.
PO 4: Describe potential limitations.

Programme Specific Outcomes (PSOs):

PSO 1: Researcher should be able to understand a general definition of research design.
PSO 2: Researchers should be able to identify the overall process of designing a research study from its commencement to its final report.
PSO 3: Researchers should be familiar with Ethics in Research, Plagiarism, skills related to writing research paper and thesis, Sources of published literature.
PSO 4: Researchers should be familiar with conducting a literature review for a scholarly educational study with the steps in the overall process.
PSO 5: Strengthening the concept of probability theory, stochastic process and Statistical Inference to carry out theoretical research.
PSO 6: Researchers should be familiar with the concept related to specialized area.
PSO 7: Identify the Research gaps in previous studies and progress over time and therefore establishes a foundation on which current research can be based.

Paper I: Research Methodology

Course Outcomes (COs)

CO1. Understand some basic concepts and properties of research and its methodologies

CO2. Identify appropriate research topics through Literature Review

CO3. Understanding and avoiding Plagiarisms

CO4. Write a research report and thesis

CO5. Expertise with different techniques involved in the simulation study and its implementation in R - software

Unit 1:

Meaning and objectives of research, defining a research problem, literature survey, Sources of published literature – journals, monographs, edited volumes, internet sources etc, Writing research paper, thesis and references. [6 hrs]

Unit 2:

Numerical Methods: Finding roots of equations – bisection method, regula-falsi method, Newton-Raphson method. Numerical integration methods, trapezoidal and Simpson's rule, Monte-Carlo integration

Unconstrained Optimization Techniques: Fibonacci and golden section methods, steepest descent method, conjugate gradient method. [14 hrs]

Unit 3:

Simulation – Reasons for simulations, dangers of simulations, role of models in simulation, development of simulation models. Techniques for generating random variates – inverse transformation method, rejection technique, Composition method, Box-Muller technique for generating normal deviates. Discrete event simulation. Simulation experiments, variance reduction techniques. [15 hrs]

Unit 4:

Jack-knifing and Bootstrap methods, MCMC methods.

Introduction to R language and packages. [13 hrs]

References:

[1] M.K. Jain, S.R.K. Iyengar & R.K. Jain (2003): Numerical Methods for Scientific and Engineering Computation, New Age International.

[2] Bazaraa M. S., Sherali S.D. and Shetty C.M. (2006), Non-Linear Programming, Wiley InterScience

[3] Louis G. Birta and Gilbert Arbez (2007), Modeling and Simulation, Springer.

Paper II: Probability and Statistical Inference

Course Outcomes (COs)

CO1: Learn to develop complex mathematical reasoning.

CO2: Know the main tools to describe a random variable, such as the probability density function, the cumulative distribution function, and the characteristic function

CO3: Recognize the importance of the central limit theorem and understand when it is appropriate to use normal approximations for the distribution of a statistic.

CO4: Possess techniques of proving theorems and thinking out counter-examples.

CO5: To learn the basics of testing of hypothesis and understand MP and UMP tests.

CO6: To learn Non-existence of UMP test and unbiased test

Unit 1:

Probability – Probability distributions, distributions of functions of random variables, distributions of order statistics from continuous and discrete population.

Modes of convergence, law of large numbers, Central limit theorems. [13 hrs]

Unit 2:

Stochastic Processes- Classification of general stochastic processes, Stationary and non-stationary stochastic processes, Markov Chains, Poisson Processes, birth-death processes and applications to queuing. [12 hrs]

Unit 3:

Statistical Inference - Sufficient statistics, MLE and its properties, limitations, Method of least squares and restricted least squares. [10 hrs]

Unit 4:

Test procedures – UMP, UMPU, LMP, and UMP invariant tests. Bayes' and minimax procedures. [13 hrs]

References:

[1] Laha R.G. and Rohatgi V.K. (1979), Probability Theory, John Wiley & Sons

[2] Bhat B.R. (2000): Stochastic Models: Analysis and Applications, New Age International.

[3] Karlin S. and Taylor, H.M. (1975): A First Course in Stochastic Processes, Vol.I, Academic Press.

[4] Medhi J. (1982): Stochastic Processes, Wiley Eastern.

[5] Ross S.M.(1983): Stochastic Processes, John Wiley & Sons.

[6] Casella G. and Berger R.L. (2002): Statistical Inference, Wadsworth Grou.

[7] Lehmann E.L. (1986): Testing Statistical Hypotheses, John Wiley.

[8] Lehman E.L. (1986): Theory of Point Estimation, John Wiley.

Paper III (a): ECONOMETRICS

Course Outcomes (COs)

CO1: A broad knowledge of regression analysis relevant for analysing economic data.

CO2: Learn estimation of model parameters ,inference problems in case of simple and multiple linear regression model

CO3: Estimate the model parameters of regression model when some of the basic ideal conditions are violated

CO4: To learn basic idea of different smoothing techniques

CO5: Understand the estimation techniques and inference procedure in case of simultaneous equations model

Unit 1:

Multiple linear regression Analysis: Least Squares Estimation and properties. Restricted least squares estimators, mixed regression estimators. Testing linear restrictions.

[10 hrs]

Unit 2:

Regression diagnostics and specification test: Residuals interpretation. Influential observations, Recursive residuals. Application of recursive residuals. Specification error. Specification error tests. [10 hrs]

Unit3:

Violation of classical assumptions; Stochastic explanatory variables, heteroscedasticity, autocorrelation, non-normality of the disturbances. Detection and remedial measures. Multicollinearity; Consequences, detection. Ridge estimator and its properties. Shrinkage estimators. ridge regression. [16 hrs]

Unit 4:

Non-parametric regression: Basic idea of smoothing, non-parametric density estimation. Kernel smoothing and local polynomial kernel estimators of regression function and their statistical properties. The partial linear regression model. [12 hrs]

References:

1. Badi H.Baltagi (1998) *Econometrics* 3rd Ed. Springer
2. Dilip M. Nachane(2006): Econometrics-Theoretical Foundations and Empirical Perspective, Oxford University Press, New Delhi.
3. Fombay T.B., Hill R.C. and Johnson S.R. (1988) Advanced *Econometric Methods*, Springer- Verlag.
4. Hardle (1990*) Applied Nonparametric regression,* Cambridge University
5. Johnson J. And Dinardo J.(1997) *Econometric Methods* 4th Ed. McGraw-Hill Companies Inc.,
6. Vinod H D and Aman Ullah (1980) *Recent Developments in Regression methods,* Marcel Deckker.
7. William H Green(2000) *Econometric Analysis*, 4th Ed. Prentice Hall.

Paper III (b): Inventory Models

Course Outcomes (COs)

CO1. Build inventory systems through a strategic approach to control inventory levels and financial risks when exporting and/or importing on a global basis.

CO2. Incorporate reuse and recycling practices into inventory management systems through strategic reverse logistics processes and circular supply chains.

CO3. Examine current business model and supply chain practices to identify the potential value of transitioning to a circular economy business model.

Unit 1:

Nature of Inventory problems. Basic concept of Inventory systems, inventory policies, various costs. Deterministic, Probabilistic and Stochastic models. (S-1,S) system, (s, S) system, (Q, r) system. [12 hrs]

Unit 2:

Inventory for decaying items. Inventory with time varying demand. Inventory models with price change. [10 hrs]

Unit 3:

Net present value – discounted cash flow approach. Trade credit policies in inventory models. [10 hrs]

Unit 4:

Periodic review models - Multi-period inventory models, dynamic programming solution. Stochastic inventory models – Poisson demand constant lead time and random lead time models. [16 hrs]

References:

[1] Naddor E (1982): Inventory Systems, John Wiley & Sons.

[2] Johnson L A and Montgomery D.C. (1974): Operations Research in Production Planning, Scheduling and Inventory Control, John Wiley & Sons.

[3] Sivazlian B.D. and Stanfel L.E. (1975) : Analysis of systems in Operations Research, Prentice Hall.

[4] Ronald A Howard (1966) Dynamic programming and Markov Processes, The MIT Press, Massachusetts, USA.

Paper III (c): Financial Models

Course Outcomes (COs)

CO1: The ability to model the returns.

CO2: The ability to understand the basic concepts of financial system.

CO3: The ability to explain portfolio theory.

CO4: The ability to understand Black scholar properties and assumptions.

CO5: The ability to deal with forward contracts and futures

CO6: The ability to differentiate between various time series models.

Unit 1:

Concepts of financial markets. Call and put options, European option, American options and other options. Modeling returns and basic elements of stochastic calculus. Brownian motion, Ito integral and Ito lemma. Generating stock prices based on diffusion process. Applications of Martingales. [12 hrs]

Unit 2:

Arbitrage theorem. The Black-Scholes formula, properties of the Black-Scholes option cost, the delta hedging arbitrage strategy. Call options on dividend-paying securities, modeling the prices by adding jumps to geometric Brownian motion. [12 hrs]

Unit 3:

Portfolio theory – trading off expected return and risk. The two fund theorem, the one fund theorem, the capital market line, the security market line, CAPM. Arbitrage pricing theory. Utility functions, risk aversion. Portfolio choice theorem.

Value at Risk (VAR) – Nonparametric and parametric estimation of VAR without asset, VAR for portfolio of assets, Copulae and VAR, Statistics of extreme risks. [14 hrs]

Unit 4:

Financial Time Series – Stationary process, autocorrelation function, AR(1) process, lag-operator, the market price of risk, the random walk hypothesis, unit root tests, Dickey-Fuller tests, variance ratio tests, ARCH(1), ARCH(q), and GARCH(1,1) models. Certain other ARCH models. Estimation and Fitting of GARCH models, extensions of the GARCH model. [10 hrs]

References:

[1] David Ruppert (2004) "Statistics and Finance an Introduction" – Springer International Edition.

[2] Sheldon M. Ross (2003): "An elementary introduction to Mathematical Finance", Cambridge University Press.

[3] David G Luenberger (1998): "Investment Science", Oxford University Press (Indian Edition 2008)

[4] John C. Hull (2008) " Options, Futures and other derivatives", Pearson Education India.

[5] Ales Cerny (2006) " Mathematical Techniques in Finance Tools for Incomplete Markets", New Age Publications.

[6] Jurgen Franke, Wolfgang K Hardle, Christian M Hafner (2008) "Statistics of Financial Markets", Springer.

Paper III (d): Financial Time Series

Course Outcomes (COs)

CO1: The ability to approach and analyze financial time series

CO2: The ability to differentiate between various time series models.

CO3: The ability to perform cross-validation of the model developed.

CO4: The ability to forecast future observations of the time series.

CO5: A running knowledge of R for applied time series analysis.

Unit 1:

Financial time series and their characteristics: Assets and Markets, Asset Returns, Distribution of returns, empirical properties of returns, Market Indexes. [9 hrs]

Unit 2:

Stationary process. Autocorrelation function, Simple Autoregressive, Moving Average, Autoregressive moving average(ARMA) and seasonal ARIMA models.

Unit root non-stationarity, Testing for unit roots, Dickey-Fuller Tests, and its extension. Co-integration and error correction models, Vector autoregressive (VAR) models. [15 hrs]

Unit 3:

Conditional Heteroscedastic models: Volatility, Characteristic of volatility, model building. The Autoregressive Conditional Heteroscedastic (ARCH) model. Properties of ARCH model. Order determination, estimation and forecasting. [12 hrs]

Unit 4:

The GARCH model and properties. Estimation and forecasting. Elementary properties of EGARCH and M-GARCH models. The stochastic volatility model. Value at Risk(VaR). An econometric approach to VaR calculation. [12 hrs]

References:

1. Rucy S. Tsay (2009): *Analysis of Financial Time Series*, 2nd Ed. Wiley Series in Probability and Statistics, ISBN 978-81-265-2369-6.

2. Christian Gourieroux G and Joann Jasiak (2005): *Financial Econometrics*, New Age publications, ISBN 81-224-1697-7.

3. Dilip M.Nachane (2006) *ECONOMETRICS, Theoretical Foundations and Empirical Perspectives*, ISBN-10-0-19-564790-4, Oxford University Press, New Delhi.

4. David Ruppert (2004) "Statistics and Finance an Introduction" – Springer International Edition.

Paper III (e):

Stochastic Models in Operations Research

Course Outcomes (COs)

CO1: To know about renewal theory and its basic properties.

CO2: To solve the problems related to dynamic programming problems.

CO3: Understanding Markov decision processes.

CO4: Application of different theories to finance

Unit 1:

Renewal theory: renewal function and its properties, elementary and key renewal theorems, , Renewal-Reward Processes, Renewal Reward Theorem, Regenerative processes. Applications [12 hrs]

Unit 2:

Continuous time Markov chain, Poisson process and Pure Jump Markov processes: a review of main results. Birth and Death processes, Applications to Queuing theory, inventory analysis, communication models, Loss Models, applications in finance. [14 hrs]

Unit 3:

Dynamic programming, characteristics of dynamic programming problems, deterministic dynamic programming, probabilistic dynamic programming. [10 hrs]

Unit 4:

Markov decision processes: Markov process with rewards- solution by recurrence relation, policy iteration and value iteration. Properties of policy iteration method and its application to inventory problems. [12 hrs]

References:

[1] Henk C. Tijms, (1986) Stochastic Modelling and Analysis, Wiley.

[2] Henk C. Tijms (2003) A first course in Stochastic Models, Wiley.

[2] Medhi, J. (1982) Stochastic Processes, Wiley Eastern.

[3] Ross, S.M. (1983) Stochastic Processes, Wiley.

[4] Bhat, B.R. (2000) Stochastic Models : Analysis and Applications, New Age International Publications.

[5] Ronald A Howard (1966) Dynamic programming and Markov Processes, The MIT Press, Massachusetts, USA.

[6] Hillier and Lieberman(2001): Introduction to Operations Research, Mc Grow Hill.

Paper III (f): Statistical Computing

Course Outcomes (COs)

CO1: Understanding applications of statistics theory in software

CO2: To learn the Machine learning tools

CO3: To strengthen the coding capability

CO4: To study the Monte Carlo methods

Unit 1:

EM Algorithm- MLE, Incomplete data problems. E- and M-steps. Examples of Non-applicability of EM algorithm, complete data from Exponential family, normal mixtures. Convergence of the EM Algorithm. [10 hrs]

Unit 2:

Genetic Algorithms(GA)- Classical search and Optimisation Techniques, Working principle of GA, understanding how GAs work, constraint handling. Theoretical Modeling of Genetic Algorithms- Functional Decomposition method approach, Statistical Dynamics Approach, Dynamical Systems Model. [11 hrs]

Unit 3:

MCMC- Monte Carlo Integration, Markov Chains, stationary solutions, Importance sampling, Bayesian Inference. Metropolis-Hastings Algorithm, Gibbs sampling. Burning in Sampler, Simulated Annealing, convergence diagnostics. [15 hrs]

Unit 4:

Neural network Models- Review of Regression and classification problems. Development of Artificial Neural Networks- Multilayer Perception Architecture, Multilayer Perception model for Regression, Multilayer Perception model for classification.

R and packages related to above topics. [12 hrs]

References:

[1] Debasis Kundu and Ayanendranath Basu (2004) *"Statistical Computing*-Existing Methods and Recent Developments"-Narosa Publishing House, Chennai.

[2] Liu J (2002) "*Monte Carlo Strategies in Scientific Computing*", Springer.

[3] Casella, G., and E. I. George (1992), "Explaining the Gibbs sampler", *Am. Stat.* 46:167–174.

[4] Chib, S., and E. Greenberg (1995), "Understanding the Metropolis-Hastings algorithm", *American Statistician* 49: 327–335.