MSc / P.G. Diploma

In

Financial Mathematics

at the

Department of Mathematics

Faculty of Engineering

of

University of Moratuwa

Course Curriculum and Scheme of Evaluation M.Sc. / Post graduate Diploma Course in Financial Mathematics Course Modules

Semester 1

Requirement: 41 credits are required including Project for P.G. Diploma in Financial Mathematics

Compulsory Courses

Code	Core Module	Credits	Evaluation** %	
			Assignment	Exam
MA5100	Introduction to Statistics	3.0	20 ± 10	80 ± 20
MA5101	Financial Mathematics Techniques	4.0	20 ± 10	80 ± 20
MA5102	Operational Research Techniques I	4.0	20 ± 10	80 ± 20
MA5115	Corporate Finance	4.0	20 ± 10	80 ± 20

Elective Courses

Code	Core Module	Credits	Evaluation** %	
			Assignment	Exam
MA5104	Mathematical Methods	3.0	20 ± 10	80 ± 20
MA5108	Management Information Systems	3.0	20 ± 10	80 ± 20

Semester 2

Compulsory Courses

Code	Core Module	Credits	Evaluation** %	
			Assignment	Exam
MA5107	Actuarial Statistics	4.0	20 ± 10	80 ± 20
MA5109	Financial Time Series Analysis & Forecasting	4.0	20 ± 10	80 ± 20
MA 5116	Economics for Finance	4.0	20 ± 10	80 ± 20
MA5110	Operational Research Techniques II	4.0	20 ± 10	80 ± 20

Elective Courses

Code	Core Module	Credits	Evaluation** %	
			Assignment	Exam
MA5112	Multivariate Analysis & Econometrics	3.0	20 ± 10	80 ± 20
MA5117	Game Theory	3.0	20 ± 10	80 ± 20
MA5113	Introduction to Marketing	3.0	20 ± 10	80 ± 20

Code	Module	Credits	Evaluation %	
			Assignment	Exam
MA5114	Dissertation	20.0	Thesis	Viva
MA 5118	Research Project	4.0	Report	Viva

**This evaluation scheme is the recommended one and can be changed within the range by the Lecturer/Examiner provided that it is announced to the students at the beginning of the course

M.Sc. / Post Graduate Diploma in Financial Mathematics Subject Syllabi

<table>
<tr><td>Module Code</td><td><u>Ma5100</u></td><td>Title</td><td colspan="4">Introduction To Statistics</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">03</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives</u>:
• The aim of this course is to provide students an introductory survey of many business applications of descriptive and inferential statistics.
• This course prepares the students to utilize probabilistic models in the analysis of managerial decision problems and uses case study approaches.
• Theories learnt would be applied and analyzed in actual situations related to problems in industry.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

• The student will be able to analyze set of data and present summary report
• Decision making based on Test of Hypothesis</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

Out line of the syllabus:
Probability distribution theory with the emphasis on models and distributions associated with the Poisson process. Introduction to decision theory, including decision trees utilities, expected value of perfect and sample information.
A practical introduction to the techniques and methods of statistics. The course includes the handling and description of numerical data, sampling and hypothesis testing, confidence intervals, correlation and regression. Non-parametric methods. Many of the ideas will be illustrated by use of the statistical computer package MINITAB.</td></tr>
</table>

Module Code	MA 5101	Title	Financial Mathematics Techniques			
Credits	04	Hours/ Week	Lectures	04	Pre-Requisites	
			Lab/Tutorials	-		

Learning Objectives:

- Knowledge about international derivatives market.
- Financial market is to provide an overview of the financial management issues and decisions involved in planning and managing financial activities of the firm and view alternative ways of addressing these decisions.

Learning Outcomes

- students able to analyze stock market fluctuation
- Knowledge about international derivatives market knowledge apply to the local market .

Outline Syllabus

Forward Contracts, Future Contracts, Options, Types of Trades, Hedgers, Speculators , One-step Binomial Models, Risk Neutral valuation, Two-Step Binomial Trees, A put examples, American options. The Markov property, Continuous time processes, The process for stock price, The parameters, Ito's lemma.

The Black-Schole-Merton model: Lognormal property of stock price, The distribution of the rate return, The expected return, Volatility, Concept underlying Black-Schole-Merton differential equation, Risk neutral valuation, Black-Schole pricing formula.

Options of stock indices, currencies, and futures: Results for stock paying a known dividend yield, Options pricing formulas, Options on stock indices, Currency indices, Currency options, Future options, evaluation of future options using a binomial tree, Black's model for valuing future's options.

<table>
<tr><td>Module Code</td><td><u>MA 5102</u></td><td>Title</td><td colspan="4">Operational Research Techniques 1</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">04</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives:</u>
The objective of this course is to present scientific and mathematical approaches to use when faced with day-to-day managerial decision problems.
specific quantitative tools used to solve managerial problems.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
On successful completion of this course, students will be able to apply different quantitative techniques and sensitivity analysis in managerial decision making, using software in particular.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Linear programming problems including graphical methods, simplex methods artificial variables, duality, dual simplex methods, Transportation and assignment algorithms, balanced and unbalanced transportation problems, degeneracy, Hungarian method of assignment, transshipment problems. Network flows, maximal flow, minimal flow, minimum spanning tree, and shortest path algorithm in the network, labeling technique, connection between network flow and transportation, matrix solution.</td></tr>
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<table>
<tr><td>Module Code</td><td><u>MA5104</u></td><td>Title</td><td colspan="4">Mathematical Methods</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">03</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives</u>:
The purpose of this course is to develop an awareness of the scope and complexity of issues related to the Management of Technology.
It will develop skills for critical technology judgment and provide the student with principles and tools for technology evaluation and management.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
On successful completion of this course, students will be able to evaluate methods requirements.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Approximations by Taylor Series, Numerical Solution of System of Linear Equations: Non Iterative Methods: Gauss Elimination, LU Factorization; Iterative Methods: Gauss-Seidel and Jacobi Methods; Solution of Non-linear Equations: Bisection, Simple Iterative, Newton-Rapson; Polynomial Approximation of Functions: Lagrange Polynomials, Newton’s Divided Differences, Least Square Polynomial and Functions, Finite Differences, Interpolation and Extrapolation, Numerical Differentiation, Numerical Integration: Trapezoidal, Simpson’s Rules, Numerical Solution of Ordinary Differential Equations: Euler’s Method, Taylor Series Method.
Numerical optimization problems (direct search and simple gradient methods)Solution of set of non-linear equations. Matrix eigen value determination including direct, inverse iteration and shift of origin. Simple finite difference technique for initial-value and boundary-value problems in ordinary and partial differential equations and systems. Runge - Kutta process. Introduction to method of Finite Element Methods.</td></tr>
</table>

Module Code	MA 5107	Title	Actuarial Statistics			
Credits	04	Hours/ Week	Lectures	04	Pre-Requisites	
			Lab/Tutorials	-		

Learning Objectives:

- This course introduces several of the major mathematical ideas involved in calculating life-insurance premiums, including: compound interest and present valuation of future income streams.
- Probability distributions and expected values derived from life tables, the interpolation of probability distributions from values estimated at one-year multiples.

Learning Outcomes

- On successful completion of this course, students will be able to describe the regular probabilistic behavior of large populations of independent individuals.
- The detailed calculation of expected present values arising in Insurance problems,

Outline Syllabus: ***Section 1***

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curate future lifetime, force of mortality. Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

Section II – Insurance and Annuities

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Life insurance: Insurance payable at the moment's of death and at the end of the year of death-level benefit insurance, endowment insurance, differed insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due. Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportion able premiums, commutation functions, and accumulation type benefits.

Payment premiums, apportion able premiums, commutation functions accumulation type benefits.

Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi continuous basis, reserves based on true monthly premiums, reserves on an apportion able or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.

Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses.

Module Code	**MA5108**	**Title**	**Management Information Systems**			
Credits	**03**	**Hours/ Week**	**Lectures**	**04**	**Pre-Requisites**	
			Lab/Tutorials	**-**		

Learning Objectives:

- provide students with an in depth knowledge on human and technical factors involved in systems analysis and design and the need for a structured approached to the systems development process.
- Provide an understanding of management perspective of information systems. Provide basic understanding of the role of IT manager in an organizational context. To give an overview of ethical, legal aspects of information systems management

Learning Outcomes

- Students will be able to describe and explain the strategic importance of different information systems in an organizational setting and the different issues that have to be considered when managing them in a cost effective way.

Outline Syllabus

Organizations and Information Systems, Information Systems Planning, Managing Information and Supporting, Decision Makers, Information Systems Development, Enterprise Systems, Outsourcing, Business Continuity Planning, Managing Operations, Services and Security, Organizational Form and IT Architecture, Legal and Ethical Issues, and Overview of Electronic Commerce and Mobile Computing.

Module Code	MA 5109	Title	Financial Time Series Analysis			
Credits	04	Hours/ Week	Lectures	04	Pre-Requisites	
			Lab/Tutorials	-		

Learning Objectives:

- The purpose of this course is to provide students with introductory tools for the time series analysis of financial time series.
- Analyze of data series based on stochastic and non stochastic models.

Learning Outcomes

- On successful completion of this course, students will be able to provide more than an introductory treatment of the topics.
- Students are encouraged to pursue further study in this area if they find that the topics covered in this course.

Outline Syllabus: Definition and examples of time series, back-shift and differencing-operators, strong and weak stationarity, definition of ACF, PACF.

Definitions and properties of the MA(q), MA(∞), AR(p), AR(∞) and ARMA(p, q), in particualr their acf's, causal stationarity of AR, invertibility of MA models and causal stationarity and invertibility of ARMA; concept of spectral density function and its applications; definition and properties of integrated ARIMA(p, d, q) processes; definition and properties of random walks with or without drift.

Model selection following the AIC and BIC; brief introduction to linear prediction and calculation of forecasting intervals for normal ARMA models; point and interval forecasts for normal random walks with or without drift.

Definition and properties of the VAR (vector autoregressive) model, arrange a univariate time series as a multivariate Markov model.

Nonlinear properties of financial time series; definition and properties of the well known ARCH, GARCH etc. Cointegration in Single Equations, Modeling and Forecasting Financial Time Series.

<table>
<tr><td>Module Code</td><td><u>MA 5110</u></td><td>Title</td><td colspan="4">Operational Research Techniques II</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">04</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives:</u>
The objective of this course is to present different types of scientific and mathematical approaches for managerial decision making with quantitative and modeling tools.
An applications in practice as well as analytical models and problem solving with the use of computer software for problem solving.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
On successful completion of this course, students will be able to transform managerial situations into OR models.
Apply the techniques learned under certain, probabilistic, and uncertain situations.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>: Revised simplex algorithm. Dual Simplex algorithm, sensitivity analysis and parametric programming. Integer programming, Gomory's cutting plane, branch and bound, the knapsack problem. Delayed column generation, the cutting stock problem.
Decision Theory: Introduction, Structuring the Decision Situations, Decision Making Under Uncertainty, Decision Tree, Utility Theory.
Dynamic Programming: Introduction to Dynamic Programming under certainty and under uncertainty, Infinite State Dynamic Programming.
Waiting Line Theory: Waiting Line Situations in Practical life, Arrival Distribution, Service Distribution, Queue Discipline, introduction to Stochastic Processes, M/m/1, M/M/m Systems with Finite & Infinite Population, An Introduction to other Queuing models and Queuing networks.
Simulation and Stochastic Models: An introduction to stochastic processes and their applications. Difference equations, Markov chains. Introduction to simulation.
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Module Code	MA5112	Title	Multivariate Analysis & Econometrics			
Credits	03	Hours/ Week	Lectures	04	Pre-Requisites	
			Lab/Tutorials	-		

Learning Objectives:

- This course focuses on the application of multivariate statistical methods in a research environment.
- Data reduction of structural simplifications. Investigations of the dependent among variables.

Learning Outcomes

- On successful completion of this course, students will be able to analyze multivariate data sets using knowledge of the course.

Outline Syllabus: Multivariate Normal distribution, pdf and mgf, singular and nonsingular normal distributions, distribution of a linear form and a quadratic form of normal variables, marginal and conditional distributions. Multiple regression and multiple and partial correlation coefficients. Definition and Relationships.

MLE's of the parameters of multivariate normal distribution and their sampling distributions

Tests of hypothesis about the mean vector of a multinormal population. Introduction to Principle Components and canonical correlation coefficients and canonical variables. Cluster Analysis.

Classification problem. Discriminant analysis, Mahalanobis. Methods and applications of MANOVA

Econometrics:

Simple and multiple regression analysis; test statistics, problems of multicollinearity and misspecification; transformation of variables, dummy variables, proxy variables; serial correlation, heterosedacity; measurement errors and the Permanent Income Hypothesis; simultaneous equation bias, indirect least squares, instrumental variables estimation, two stage least squares; model evaluation.

Module Code	MA5113	Title	Introduction to Marketing			
Credits	03	Hours/ Week	Lectures	04	Pre-Requisites	
			Lab/Tutorials	-		

Learning Objectives:

- Introduces students to the principles and practices of marketing and marketing management within a business context.
- Class discussions will involve the application of theoretical concepts to the environment in which the marketing managers operate.
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Learning Outcomes

- Emphasis is placed on the application of concepts to the real marketing situations.
- Particular attention will be given to the application of modern skills and techniques to marketing management through case studies.

Outline Syllabus: The role of marketing at the corporate and business level. Marketing information and marketing research: marketing intelligence, marketing research process, junctions, design and analysis of market survey, application of analytical techniques and computer software.

Analyzing the marketing environment. Consumer markets and buyer behavior. Industrial markets and organizational buyer behavior. Market segmentation, targeting and positioning. New product development. Managing the product line. Selecting and managing marketing channels. The design of marketing communication and sales promotion. Marketing services. International marketing. Organization implementation and control of marketing programs

<table>
<tr><td>Module Code</td><td><u>MA5115</u></td><td>Title</td><td colspan="4">Corporate Finance</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">04</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives:</u>
Evaluate how a company’s strategic, operational and financing plans map into its financing and ownership structures.
Determine, analyze and recommend alternative methods for asset, ownership and/or financial changes of control of a company or its assets.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
Students will be able to determine long repayments bond valuation under the current market.
Identify the alternatives open to a company in financial distress.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Review of Time Value of Money concept and series of payments, Loan repayments, Bond valuation, Rate of return of an investment, Yield rate , IRR and NPV concept, Term structure of interest rates, Yield curve, Cash flow duration and immunization, Stocks, Fixed income investments, Foreign currency exchange rates, Capital market theory, Capital asset pricing models, Relationship between systematic risk and return, Market portfolio</td></tr>
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<table>
<tr><td>Module Code</td><td><u>MA5116</u></td><td>Title</td><td colspan="4">Economics for Finance</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">04</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives</u>:
Demonstrate an understanding of the concepts of Economics and also Opportunity cost and the use of marginal analysis to evaluate tradeoffs and make decisions.
Explain how voluntary exchange is mutually beneficial and demonstrate how specialization and trade based on comparative advantage can increase social welfare</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
Students will be able to analyze macro and micro economic concepts in the market.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Overview of economics, Nature and role of modern economics, Partial equilibrium model for competitive markets, General equilibrium theory and social welfare, Pareto efficiency of allocation, the first and second fundamental theorem of welfare economics, Parato optimality, Economics core, Fair allocations, Social choice theory, Consumption externalities, Production externality, Pigovian tax, Coase voluntary Negotiation, Missing market, public goods, Principal agent model, Decision theory approach to economics, Game theory approach to economics.</td></tr>
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<table>
<tr><td>Module Code</td><td><u>MA5117</u></td><td>Title</td><td colspan="4">Game Theory</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">03</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>04</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives</u>:
objective for this course is to introduce to models of self interest, that is, those based upon the mathematics of decision theory and game theory, and to allow you to develop skill with these models and their use for predicting and explaining social behavior.
Social behavior involves actions taken by individuals that, at least when aggregated over a group, affect other individuals.</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
Students will be able to develop an understanding of the core ideas and concepts of Game Theory.
Be able to recognize the power of abstraction and generalization, and to carry out investigative mathematical work with independent judgment.
Be able to apply rigorous, analytic, highly numerate approach to analyze and solve problems.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>
Nim and combinatorial games, What is combinatorial game theory?, Nim – rules, Combinatorial games, in particular impartial games, Equivalent games, Poker nim and the mex rule, Sums of Combinatorial Games, The Sum of n Graph Games, The Sprague Grundy Theorem, Applications Games as trees and in strategic form, Game trees, Strategies and strategy profiles, Nash equilibrium, Commitment games, Mixed strategy equilibria, Bimatrix games, Finding mixed equilibria, Degenerate games, Kuhn's theorem: behaviour strategies suffice, Subgames and subgame perfect equilibria,</td></tr>
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<table>
<tr><td>Module Code</td><td><u>MA5118</u></td><td>Title</td><td colspan="4">Research Project</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">04</td><td rowspan="2">Hours/ Week</td><td>Lectures</td><td>-</td><td rowspan="2">Pre-Requisites</td><td rowspan="2"></td></tr>
<tr><td>Lab/Tutorials</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Objectives</u>:
• Application Knowledge of the course components</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>
• Industry application of the theory</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

An approved individual research project should be based on industrial application of any of the course module with Supervision of senior staff member or expert in the relevant field of project</td></tr>
</table>

Details of the Resource Personals

From University of Moratuwa

Mr. AR Dissanayake (Course Coordinator)

B.Sc.(Col), M.Sc. (Pune-India)

Mr.T.M.J.A.Cooray

B.Sc. (Pera) ,P.G.Diploma(Pera), M.Sc.(Col). M.Phil.(Mora)

Dr. G.T.F.de Siva

B.Sc. (London),B.Sc.(Cey), M.Phil.(London), DIC, CEng, MBCS

Dr. M.Z.M.Malhardeen

B.Sc. (Cey), Ph.D.(Heriot Watt)

Dr. H.S.C. Perera

B.Sc. Eng(Mora), M.Eng.(AIT), D.Eng.(AIT)

Dr. T.S.G. Peiris
B.Sc.(Col), M.Sc., Ph.D.(SL), FRS

Mr. U.C. Jayatilake

B.Sc. Eng (Mora), M.Sc.(Mora)

Mrs. Sherin Ahamed

B.Sc.(Pera), M.Eng.(Japan), M.Sc.(PGIA)

Mr. Mohommad Firdhous

B.Sc. Eng, MSc, MBA(SL), MIET(London), CCNA

From Outside of University of Moratuwa

Dr. S.P.C. Perera
B.Sc. Eng. (Pera) M.Sc, Ph.D.(Texas Tech,USA)
Senior Lecturer
Dept. Engineering Mathematics
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International Marketing Manager
Maliban Biscuits Associates Ltd

Mr. D.D.A. Gamini
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Specialist-Group Business Operations and Control Dialog Axiata PLC

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Sir John Kotelawala Defence University