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University of Moratuwa, Sri Lanka

Curriculum and Syllabi

for the award of the

Master of Science in Financial Mathematics (SLQF 10)

Department of Mathematics

January 2024

Curriculum and Syllabi

Title: Master of Science in Financial Mathematics (SLQF-L10 Type A)

New Module Code	Module Name	Credit Value[1]	Evaluation[2] (%)	
			Continuous Assessment	Final Exam
Compulsory Module				
MA6120	Probability and Statistics	3.0	30	70
MA6121	Financial Mathematics Techniques	3.0	30	70
MA6115	Corporate Finance	4.0	30	70
MA6123	Actuarial Statistics	4.0	30	70
MA6110	Operational Research Techniques	4.0	30	70
MA6124	Financial Time Series Analysis & Forecasting	4.0	30	70
MA6116	Economics for Finance	3.0	30	70
MA6107	Computer Programming for Financial Modelling	3.0	30	70
MA5106	Research Methodology	2.0	100	-
MA6118	Independent Research	5.0	100	-
Elective Module				
MA6108	Management Information Systems	3.0	30	70
MA6122	Mathematical Methods for Finance	3.0	30	70
MA6125	Multivariate Analysis & Econometrics	3.0	30	70
MA6105	Partial Differential Equations for Finance	3.0	30	70
MA6104	Stochastic Calculus and Processes with Applications in Finance	3.0	30	70
MA6117	Game Theory	3.0	30	70

Note:

1. One (1) credit corresponds to fourteen (14) hours of lectures or equivalent.
2. The mean value in the evaluation scheme is the default value. It can be changed by the Lecturer/Examiner concerned, within the specified range, by announcement to the students at the commencement of the course unit.

Supervised Research Project relevant to the course for Master of Science Degree

[20 credits from the Research Project]

Code	Module	Credits	Evaluation (%)	
			Continuous Assessment	Written Exam
MA6114	Research Project	20	100%	-

Additional Notes

Note 1: Evaluation of the Research project is done as a series of progress reviews starting from proposal presentation and the intermediate presentations could be scheduled by the Supervisor and the course coordinator, by announcement to the students at the commencement of the research work.

Syllabi of Modules

Section 1 – Compulsory Modules [Total of 35 credits]

<table>
<tr><td>Module Code:</td><td colspan="5">MA6120</td></tr>
<tr><td>Module Name:</td><td colspan="5">Probability and Statistics</td></tr>
<tr><td>Credit Value:</td><td colspan="5">03</td></tr>
<tr><td>Core/Optional/Elective</td><td colspan="5">Compulsory Module</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Research / PBL</td><td>Others</td><td>Independent Learning</td></tr>
<tr><td>28 hours</td><td>28 hours</td><td></td><td></td><td>90 hours</td></tr>
<tr><td colspan="6">Intended Learning Outcomes:
On the satisfactory completion of this module, students will be able to;

1. Analyze Data and Produce Summary Reports
2. Apply Test of Hypothesis to Make Decisions
3. Examine Multivariate Data Sets
4. Utilize Statistical Inference Methods in Financial Problem Solving</td></tr>
<tr><td colspan="6">Outline Syllabus:
Probability theory, conditional probability, Bayes' theorem, discrete and continuous random variables and their parameter estimations, properties of estimators, Central Limit Theorem, confidence intervals, properties of known probability distributions (Binomial, Poisson, Normal, and Exponential), statistical hypothesis testing, describing data sets using various statistical indicators, summarizing data, methods of presenting variability in data series, use of software for explanatory data analysis. Introduction to non-parametric techniques. 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 R or Python programming language.</td></tr>
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Module Code:	MA6121				
Module Name:	Financial Mathematics Techniques				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

1. Analyze and evaluate various financial derivatives, their pricing models, and the underlying principles of risk-neutral valuation.

2. Apply binomial models, continuous-time processes, and the Black-Scholes-Merton model to analyse and price a wide range of derivative instruments.

3. Synthesize Concepts and Solve Problems in Financial Decision-Making

Outline Syllabus:

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

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

Module Code:	MA6110				
Module Name:	Operational Research Techniques				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Identify appropriate OR techniques for a given real world problem.
2. Choose an appropriate algorithm for the given OR problem.
3. Perform sensitivity analysis and apply relevant software applications in managerial decision making.

Outline Syllabus:

Linear programming: simplex methods, dual simplex methods, duality in linear programming, sensitivity analysis Transportation, and assignment algorithms, balanced and unbalanced transportation problems, degeneracy, Hungarian method of assignment, transshipment problems.

Network analysis: 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.

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.

Module Code:	MA6123				
Module Name:	Actuarial Statistics				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Describe Probabilistic Behaviour of Large Populations
2. Calculate Expected Present Values in Insurance Problems
3. Evaluate Insurance and Annuity Benefits using Mathematical Models.

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 relationship 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 decrements, 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 moments 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 apportionable 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 expense types of expenses, per policy expenses.

Module Code:	MA6124				
Module Name:	Financial Time Series Analysis & Forecasting				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Define Time Series Concepts and Properties
2. Analyze Properties and Models of Time Series
3. Apply Advanced Time Series Techniques in Financial Analysis

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 $MA(q)$, $MA(\infty)$, AR(p), AR(∞) and ARMA(p, q), in particular 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.

Practical: Time series data analysis using computer software

Module Code:	MA6115				
Module Name:	Corporate Finance				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Apply Time Value of Money Concepts to Financial Analysis
2. Analyze Investment Performance using Internal Rate of Return (IRR) and Net Present Value (NPV) Concepts
3. Evaluate Market Risks and Returns using Capital Asset Pricing Models (CAPM)

Outline Syllabus:

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

Practical: Use computer software and programs for financial calculations

Module Code:	MA6116				
Module Name:	Economics for Finance				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Build a Solid Understanding of Economics, Microeconomics, Macroeconomics, and Finance
2. Apply Economic Analysis to Understand Economic Events and Everyday Problems
3. Evaluate Economic Concepts and Theories in Various Contexts

Outline Syllabus:

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.

Module Code:	MA6107				
Module Name:	Computer Programming for Financial Modelling				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	14 hours	56 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Develop skills required for financial data science, big data analysis and machine learning, including open-source tools and libraries, python, statistical analysis, sql, and relational databases.
2. Extracting and graphing financial data with relevant python libraries and use sql to query financial data sets to identify causes that impact financial events.
3. Generating visualizations and conducting statistical tests to provide insight on financial trends.

Outline Syllabus:

- **Introduction to Python programming**
  - Apply Python programming logic Variables, Data Structures, Branching, Loops, Functions, Objects and classes.
  - Demonstrate proficiency in using Python libraries such as Pandas & Numpy and developing code using Jupyter Notebooks.
  - Access and web scrape data using APIs and Python libraries like Beautiful Soup.
- **Statistics for finance with Python**
  - Write Python code to conduct various statistical tests including a T test, an ANOVA, and regression analysis.
  - Interpret the results of the statistical analysis after conducting hypothesis testing.
  - Calculate descriptive statistics and visualization by writing Python code.
- **Databases and SQL with Python**
  - Analyse finance data within a database using SQL and Python.
  - Create a relational database and work with multiple tables using DDL commands.
  - Construct basic to intermediate level SQL queries using DML commands.
  - Compose more powerful queries with advanced SQL techniques like views, transactions, stored procedures, and joins.

Module Code:	MA6106				
Module Name:	Research Methodology				
Credit Value:	02				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	14 hours	28 hours			60 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Identify Feasible Research Problems and Set Research Objectives
2. Conduct Research in the Respective Subject Area
3. Compose Academic Reports Utilizing Scientific Writing.

Outline Syllabus:

- Ethics in conducting surveys and experiments, data collection, reporting and publication
- Obtaining ethical clearance
- Meaning of research, objectives, significance, and approaches of research
- Qualitative vs quantitative research
- Research methods vs research methodology
- Scientific method and research hypotheses
- Scientific writing, presentation modes of research.

Module Code:	MA6118				
Module Name:	Independent Project				
Credit Value:	05				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
			390 hours		90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Prepare Sound Research Proposals
2. Screen and Decide the Scope of a Study and Plan the Study
3. Write a Scientific Report on a Subject Matter
4. Conduct a verbal presentation on the work done.

Outline Syllabus:

The aim of the project is to provide an opportunity to independently apply the knowledge in the field of finance and further practice in scientific writing and presentation of results in order to make the students more comfortable to tackle the real-world problems.

Section 2 – Elective Modules [Total of 18 Credits]

<table>
<tr><td>Module Code:</td><td colspan="5">MA6122</td></tr>
<tr><td>Module Name:</td><td colspan="5">Mathematical Method for Finance</td></tr>
<tr><td>Credit Value:</td><td colspan="5">03</td></tr>
<tr><td>Core/Optional/Elective</td><td colspan="5">Elective</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Research / PBL</td><td>Others</td><td>Independent Learning</td></tr>
<tr><td>28 hours</td><td>28 hours</td><td></td><td></td><td>90 hours</td></tr>
<tr><td colspan="6">Intended Learning Outcomes:
On the satisfactory completion of this module, students will be able to;

1. Evaluate Mathematical Methods for Technology Evaluation and Management
2. Apply Theoretical Knowledge and Practical Skills in Numerical Methods for Finance
3. Analyze and Select Numerical Optimization and Solution Techniques</td></tr>
<tr><td colspan="6">Outline Syllabus:
• 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:	MA6125				
Module Name:	Multivariate Analysis & Econometrics				
Credit Value:	03				
Core/Optional/Elective	Elective				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Demonstrate the ability to integrate statistical and econometric methods cohesively.
2. Develop critical thinking skills to assess the appropriateness of statistical and econometric models in various contexts.
3. Communicate complex statistical and econometric concepts effectively to diverse audiences, including both technical and non-technical stakeholders.

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:	MA 6105				
Module Name:	Partial Differential Equations for Finance				
Credit Value:	03				
Core/Optional/Elective	Elective				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

1. Articulate specialized mathematical concepts within the field of partial differential equations.
2. Recognise the complex connections between stochastic analysis and partial differential equations.
3. Apply sophisticated mathematical modeling skills to problems in partial differential equations that relate to financial markets;

Outline Syllabus:

Introduces parabolic partial differential equations (PDEs) with financial applications. Basic solutions concepts and properties will be covered. Connections between PDE and probabilistic formulations will be established via the Feynman-Kac formula. Option pricing theory will be explored via the Black-Scholes equation, Dupire's equation, and Fokker-Planck equation for various models including local volatility and stochastic volatility models, with extensions to look back, Asian, basket, Bermudan and American options. The dynamic programming principle and theory of stochastic control will be briefly introduced. You will learn to derive relevant PDEs for financial problems and solve them using analytical or numerical methods.

Module Code:	MA6108				
Module Name:	Management Information Systems				
Credit Value:	03				
Core/Optional/Elective	Elective				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

1. Describe and explain the strategic importance of different information systems in an organizational setting.
2. Describe and explain the different issues that must be considered when cost-effectively managing them.

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:	MA6117				
Module Name:	Game Theory				
Credit Value:	03				
Core/Optional/Elective	Elective				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

1. Develop an understanding of the core ideas and concepts of Game Theory.
2. Recognize the power of abstraction and generalization, and to carry out investigative mathematical work with independent judgment.
3. Apply rigorous, analytic, highly numerate approach to analyse and solve problems.

Outline Syllabus:

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.

Module Code:	MA6104				
Module Name:	Stochastic Calculus and Processes with Applications in Finance				
Credit Value:	03				
Core/Optional/Elective	Elective				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

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1. Discuss Modeling Financial Markets with Stochastic Processes
2. Analyze Risk-Neutral Pricing and the Feynman-Kac Theorem
3. Evaluate Applications of Martingales and Martingale Measures in Financial Markets

Outline Syllabus:

Filtrations and generalized conditional expectation; the Girsanov theorem and the RadonNikodym process; martingales; Brownian motion; Ito integration and processes; the Black-Scholes formula; risk-neutral pricing and the Feynman-Kac theorem. Applications to financial instruments

discusses modeling financial markets with stochastic processes, including the famous BlackScholes–Merton (BSM) model. It introduces the pertinent mathematical concepts of ‘predictability’ in application to investment portfolios and hedging strategies, and martingales and martingale measures in application to the concepts of efficiency and absence of arbitrage in financial markets. Lévy models, which improve on the performance of BSM, are introduced to take account of different stylized features of the markets. The pricing of derivative securities in market models based on Lévy processes is also covered.

University of Moratuwa, Sri Lanka

Curriculum and Syllabi

for the award of the

Master in Financial Mathematics (SLQF 09)

Department of Mathematics

January 2024

Curriculum and Syllabi

Title: Masters Degree in Financial Mathematics (SLQF-L9)

New Module Code	Module Name	Credit Value[1]	Evaluation[2] (%)	
			Continuous Assessment	Final Exam
Compulsory Module				
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MA6121	Financial Mathematics Techniques	3.0	30	70
MA6115	Corporate Finance	4.0	30	70
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MA6124	Financial Time Series Analysis & Forecasting	4.0	30	70
MA6116	Economics for Finance	3.0	30	70
MA6107	Computer Programming for Financial Modelling	3.0	30	70
MA5106	Research Methodology	2.0	100	-
MA6118	Independent Research	5.0	100	-
Optional Module				
MA6108	Management Information Systems	3.0	30	70
MA6122	Mathematical Methods for Finance	3.0	30	70
MA6125	Multivariate Analysis & Econometrics	3.0	30	70
MA6105	Partial Differential Equations for Finance	3.0	30	70
MA6104	Stochastic Calculus and Processes with Applications in Finance	3.0	30	70
MA6117	Game Theory	3.0	30	70

Note:

3. One (1) credit corresponds to fourteen (14) hours of lectures or equivalent.
4. The mean value in the evaluation scheme is the default value. It can be changed by the Lecturer/Examiner concerned, within the specified range, by announcement to the students at the commencement of the course unit.

Syllabi of Modules

Section 1 – Compulsory Modules [Total of 35 credits]

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<tr><td>Module Code:</td><td colspan="5">MA6120</td></tr>
<tr><td>Module Name:</td><td colspan="5">Probability and Statistics</td></tr>
<tr><td>Credit Value:</td><td colspan="5">03</td></tr>
<tr><td>Core/Optional/Elective</td><td colspan="5">Compulsory Module</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Research / PBL</td><td>Others</td><td>Independent Learning</td></tr>
<tr><td>28 hours</td><td>28 hours</td><td></td><td></td><td>90 hours</td></tr>
<tr><td colspan="6">Intended Learning Outcomes:
On the satisfactory completion of this module, students will be able to;

5. Analyze Data and Produce Summary Reports
6. Apply Test of Hypothesis to Make Decisions
7. Examine Multivariate Data Sets
8. Utilize Statistical Inference Methods in Financial Problem Solving</td></tr>
<tr><td colspan="6">Outline Syllabus:
Probability theory, conditional probability, Bayes' theorem, discrete and continuous random variables and their parameter estimations, properties of estimators, Central Limit Theorem, confidence intervals, properties of known probability distributions (Binomial, Poisson, Normal, and Exponential), statistical hypothesis testing, describing data sets using various statistical indicators, summarizing data, methods of presenting variability in data series, use of software for explanatory data analysis. Introduction to non-parametric techniques. 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 R or Python programming language.</td></tr>
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Module Code:	MA6121				
Module Name:	Financial Mathematics Techniques				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

4. Analyze and evaluate various financial derivatives, their pricing models, and the underlying principles of risk-neutral valuation.

5. Apply binomial models, continuous-time processes, and the Black-Scholes-Merton model to analyse and price a wide range of derivative instruments.

6. Synthesize Concepts and Solve Problems in Financial Decision-Making

Outline Syllabus:

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

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

Module Code:	MA6110				
Module Name:	Operational Research Techniques				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Identify appropriate OR techniques for a given real world problem.
5. Choose an appropriate algorithm for the given OR problem.
6. Perform sensitivity analysis and apply relevant software applications in managerial decision making.

Outline Syllabus:

Linear programming: simplex methods, dual simplex methods, duality in linear programming, sensitivity analysis Transportation, and assignment algorithms, balanced and unbalanced transportation problems, degeneracy, Hungarian method of assignment, transshipment problems.

Network analysis: 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.

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.

Module Code:	MA6123

Module Name:	Actuarial Statistics				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Describe Probabilistic Behavior of Large Populations
5. Calculate Expected Present Values in Insurance Problems
6. Evaluate Insurance and Annuity Benefits using Mathematical Models

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 relationship 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 decrements, 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 moments 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 apportionable 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 expense types of expenses, per policy expenses.

Module Code:	MA6124				
Module Name:	Financial Time Series Analysis & Forecasting				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Define Time Series Concepts and Properties
5. Analyze Properties and Models of Time Series
6. Apply Advanced Time Series Techniques in Financial Analysis

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 particular 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.

Module Code:	MA6115				
Module Name:	Corporate Finance				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Apply Time Value of Money Concepts to Financial Analysis
5. Analyze Investment Performance using Internal Rate of Return (IRR) and Net Present Value (NPV) Concepts
6. Evaluate Market Risks and Returns using Capital Asset Pricing Models (CAPM)

Outline Syllabus:

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

Module Code:	MA6116				
Module Name:	Economics for Finance				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Build a Solid Understanding of Economics, Microeconomics, Macroeconomics, and Finance
5. Apply Economic Analysis to Understand Economic Events and Everyday Problems
6. Evaluate Economic Concepts and Theories in Various Contexts

Outline Syllabus:

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.

Module Code:	MA6107				
Module Name:	Computer Programming for Financial Modelling				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	14 hours	56 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Develop skills required for financial data Science, Big Data analysis and Machine learning, including open-source tools and libraries, Python, Statistical Analysis, SQL, and relational databases.
5. Extracting and graphing financial data with relevant Python libraries and use SQL to query financial data sets to identify causes that impact financial events.
6. Generating visualizations and conducting statistical tests to provide insight on financial trends.

Outline Syllabus:

- **Introduction to Python programming**
  - Apply Python programming logic Variables, Data Structures, Branching, Loops, Functions, Objects and classes.
  - Demonstrate proficiency in using Python libraries such as Pandas & Numpy and developing code using Jupyter Notebooks.
  - Access and web scrape data using APIs and Python libraries like Beautiful Soup.
- **Statistics for finance with Python**
  - Write Python code to conduct various statistical tests including a T test, an ANOVA, and regression analysis.
  - Interpret the results of the statistical analysis after conducting hypothesis testing.
  - Calculate descriptive statistics and visualization by writing Python code.
- **Databases and SQL with Python**
  - Analyse finance data within a database using SQL and Python.
  - Create a relational database and work with multiple tables using DDL commands.
  - Construct basic to intermediate level SQL queries using DML commands.
  - Compose more powerful queries with advanced SQL techniques like views, transactions, stored procedures, and joins.

Module Code:	MA6106				
Module Name:	Research Methodology				
Credit Value:	02				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	14 hours	28 hours			60 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Identify Feasible Research Problems and Set Research Objectives
5. Conduct Research in the Respective Subject Area
6. Compose Academic Reports Utilizing Scientific Writing.

Outline Syllabus:

- Ethics in conducting surveys and experiments, data collection, reporting and publication
- Obtaining ethical clearance
- Meaning of research, objectives, significance, and approaches of research
- Qualitative vs quantitative research
- Research methods vs research methodology
- Scientific method and research hypotheses
- Scientific writing, presentation modes of research.

Module Code:	MA6118				
Module Name:	Independent Research				
Credit Value:	05				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
			390 hours		90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

5. Prepare Sound Research Proposals
6. Screen and Decide the Scope of a Study and Plan the Study
7. Write a Scientific Report on a Subject Matter
8. Conduct a verbal presentation on the work done.

Outline Syllabus:

The aim of the project is to provide an opportunity to independently apply the knowledge in the field of finance and further practice in scientific writing and presentation of results in order to make the students more comfortable to tackle the real-world problems.

Section 2 – Optional Modules [Total of 18 Credits]

Module Code:	MA6122

Module Name:	Mathematical Method for Finance				
Credit Value:	03				
Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

5. Evaluate Mathematical Methods for Technology Evaluation and Management
6. Apply Theoretical Knowledge and Practical Skills in Numerical Methods for Finance
7. Analyze and Select Numerical Optimization and Solution Techniques

Outline Syllabus:

- 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.

Module Code:	MA6125
Module Name:	Multivariate Analysis & Econometrics

Credit Value:	03				
Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Demonstrate the ability to integrate statistical and econometric methods cohesively.
5. Develop critical thinking skills to assess the appropriateness of statistical and econometric models in various contexts.
6. Communicate complex statistical and econometric concepts effectively to diverse audiences, including both technical and non-technical stakeholders.

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:	MA 6105

Module Name:	Partial Differential Equations for Finance				
Credit Value:	03				
Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Articulate specialized mathematical concepts within the field of partial differential equations.
5. Recognise the complex connections between stochastic analysis and partial differential equations.
6. Apply sophisticated mathematical modeling skills to problems in partial differential equations that relate to financial markets;

Outline Syllabus:

Introduces parabolic partial differential equations (PDEs) with financial applications. Basic solutions concepts and properties will be covered. Connections between PDE and probabilistic formulations will be established via the Feynman-Kac formula. Option pricing theory will be explored via the Black-Scholes equation, Dupire's equation, and Fokker-Planck equation for various models including local volatility and stochastic volatility models, with extensions to look back, Asian, basket, Bermudan and American options. The dynamic programming principle and theory of stochastic control will be briefly introduced. You will learn to derive relevant PDEs for financial problems and solve them using analytical or numerical methods.

Module Code:	MA6108
Module Name:	Management Information Systems
Credit Value:	03

Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

3. Describe and explain the strategic importance of different information systems in an organizational setting.
4. Describe and explain the different issues that must be considered when cost-effectively managing them.

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:	MA6117
Module Name:	Game Theory

Credit Value:	03				
Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

4. Develop an understanding of the core ideas and concepts of Game Theory.
5. Recognize the power of abstraction and generalization, and to carry out investigative mathematical work with independent judgment.
6. Apply rigorous, analytic, highly numerate approach to analyse and solve problems.

Outline Syllabus:

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.

Module Code:	MA6104

Module Name:	Stochastic Calculus and Processes with Applications in Finance				
Credit Value:	03				
Core/Optional/Elective	Optional				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

4. Discuss Modeling Financial Markets with Stochastic Processes
5. Analyze Risk-Neutral Pricing and the Feynman-Kac Theorem
6. Evaluate Applications of Martingales and Martingale Measures in Financial Markets

Outline Syllabus:

Filtrations and generalized conditional expectation; the Girsanov theorem and the RadonNikodym process; martingales; Brownian motion; Ito integration and processes; the Black-Scholes formula; risk-neutral pricing and the Feynman-Kac theorem. Applications to financial instruments

discusses modeling financial markets with stochastic processes, including the famous BlackScholes–Merton (BSM) model. It introduces the pertinent mathematical concepts of 'predictability' in application to investment portfolios and hedging strategies, and martingales and martingale measures in application to the concepts of efficiency and absence of arbitrage in financial markets. Lévy models, which improve on the performance of BSM, are introduced to take account of different stylized features of the markets. The pricing of derivative securities in market models based on Lévy processes is also covered.

University of Moratuwa, Sri Lanka

Curriculum and Syllabi

for the award of the

PG Dip. in
Financial Mathematics
(SLQF 08)

Department of Mathematics

January 2024

Curriculum and Syllabi

Title: PG Dip. In Financial Mathematics (SLQF-L8)

New Module Code	Module Name	Credit Value	Evaluation (%)	
			Continuous Assessment	Final Exam
Compulsory Module				
MA6120	Probability and Statistics	3.0	30	70
MA6121	Financial Mathematics Techniques	3.0	30	70
MA6115	Corporate Finance	4.0	30	70
MA6123	Actuarial Statistics	4.0	30	70
MA6110	Operational Research Techniques	4.0	30	70
MA6124	Financial Time Series Analysis & Forecasting	4.0	30	70
Elective Module				
MA5107	Computer Programming for Financial Modelling	3.0	30	70
MA 5116	Economics for Finance	3.0	30	70

Note:

5. One (1) credit corresponds to fourteen (14) hours of lectures or equivalent.
6. The mean value in the evaluation scheme is the default value. It can be changed by the Lecturer/Examiner concerned, within the specified range, by announcement to the students at the commencement of the course unit.

Syllabi of Modules

Section 1 – Compulsory Modules [Total of 22 credits]

<table>
<tr><td>Module Code:</td><td colspan="5">MA6120</td></tr>
<tr><td>Module Name:</td><td colspan="5">Probability and Statistics</td></tr>
<tr><td>Credit Value:</td><td colspan="5">03</td></tr>
<tr><td>Core/Optional/Elective</td><td colspan="5">Compulsory Module</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Research / PBL</td><td>Others</td><td>Independent Learning</td></tr>
<tr><td>28 hours</td><td>28 hours</td><td></td><td></td><td>90 hours</td></tr>
<tr><td colspan="6">Intended Learning Outcomes:
On the satisfactory completion of this module, students will be able to;

9. Analyze Data and Produce Summary Reports
10. Apply Test of Hypothesis to Make Decisions
11. Examine Multivariate Data Sets
12. Utilize Statistical Inference Methods in Financial Problem Solving

13</td></tr>
<tr><td colspan="6">Outline Syllabus:
Probability theory, conditional probability, Bayes' theorem, discrete and continuous random variables and their parameter estimations, properties of estimators, Central Limit Theorem, confidence intervals, properties of known probability distributions (Binomial, Poisson, Normal, and Exponential), statistical hypothesis testing, describing data sets using various statistical indicators, summarizing data, methods of presenting variability in data series, use of software for explanatory data analysis. Introduction to non-parametric techniques. 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 R or Python programming language.</td></tr>
</table>

Module Code:	MA6121				
Module Name:	Financial Mathematics Techniques				
Credit Value:	03				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to ;

7. Analyze and evaluate various financial derivatives, their pricing models, and the underlying principles of risk-neutral valuation.

8. Apply binomial models, continuous-time processes, and the Black-Scholes-Merton model to analyse and price a wide range of derivative instruments.

9. Synthesize Concepts and Solve Problems in Financial Decision-Making

Outline Syllabus:

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

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

Module Code:	MA6110				
Module Name:	Operational Research Techniques				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Identify appropriate OR techniques for a given real world problem.
8. Choose an appropriate algorithm for the given OR problem.
9. Perform sensitivity analysis and apply relevant software applications in managerial decision making.

Outline Syllabus:

Linear programming: simplex methods, dual simplex methods, duality in linear programming, sensitivity analysis Transportation, and assignment algorithms, balanced and unbalanced transportation problems, degeneracy, Hungarian method of assignment, transshipment problems.

Network analysis: 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.

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.

Module Code:	MA6123				
Module Name:	Actuarial Statistics				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Describe the Probabilistic Behaviour of Large Populations
8. Calculate Expected Present Values in Insurance Problems
9. Evaluate Insurance and Annuity Benefits using Mathematical Models.

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 relationship 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 decrements, 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 moments 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 apportionable 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 expense types of expenses, per policy expenses.

Module Code:	MA6124				
Module Name:	Financial Time Series Analysis & Forecasting				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Define Time Series Concepts and Properties
8. Analyze Properties and Models of Time Series
9. Apply Advanced Time Series Techniques in Financial Analysis

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 particular 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.

Module Code:	MA6115				
Module Name:	Corporate Finance				
Credit Value:	04				
Core/Optional/Elective	Compulsory Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	42 hours	28 hours			130 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Apply Time Value of Money Concepts to Financial Analysis
8. Analyze Investment Performance using Internal Rate of Return (IRR) and Net Present Value (NPV) Concepts
9. Evaluate Market Risks and Returns using Capital Asset Pricing Models (CAPM)

Outline Syllabus:

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

Section 2 – Elective Modules [Total of 6 Credits]

Module Code:	MA6116				
Module Name:	Economics for Finance				
Credit Value:	03				
Core/Optional/Elective	Elective Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	28 hours	28 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Build a Solid Understanding of Economics, Microeconomics, Macroeconomics, and Finance
8. Apply Economic Analysis to Understand Economic Events and Everyday Problems
9. Evaluate Economic Concepts and Theories in Various Contexts

Outline Syllabus:

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.

Module Code:	MA6107				
Module Name:	Computer Programming for Financial Modelling				
Credit Value:	03				
Core/Optional/Elective	Elective Module				
Hourly Breakdown	Theory	Practical	Research / PBL	Others	Independent Learning
	14 hours	56 hours			90 hours

Intended Learning Outcomes:

On the satisfactory completion of this module, students will be able to;

7. Develop skills required for financial data Science, Big Data analysis and Machine learning, including open-source tools and libraries, Python, Statistical Analysis, SQL, and relational databases.
8. Extracting and graphing financial data with relevant Python libraries and use SQL to query financial data sets to identify causes that impact financial events.
9. Generating visualizations and conducting statistical tests to provide insight on financial trends.

Outline Syllabus:

- **Introduction to Python programming**
  - Apply Python programming logic Variables, Data Structures, Branching, Loops, Functions, Objects and classes.
  - Demonstrate proficiency in using Python libraries such as Pandas & Numpy and developing code using Jupyter Notebooks.
  - Access and web scrape data using APIs and Python libraries like Beautiful Soup.
- **Statistics for finance with Python**
  - Write Python code to conduct various statistical tests including a T test, an ANOVA, and regression analysis.
  - Interpret the results of the statistical analysis after conducting hypothesis testing.
  - Calculate descriptive statistics and visualization by writing Python code.
- **Databases and SQL with Python**
  - Analyse finance data within a database using SQL and Python.
  - Create a relational database and work with multiple tables using DDL commands.
  - Construct basic to intermediate level SQL queries using DML commands.
  - Compose more powerful queries with advanced SQL techniques like views, transactions, stored procedures, and joins.