Financial Engineering Quantitative Finance education @ SMU

by Kian-Guan Lim

Professor of Finance

Head, Quantitative Finance Unit

Singapore Management University

Quantitative Finance Major courses

There are **14 compulsory semester courses out of 36 for BBM degree**

- **Introductory Statistics A (STAT101) or B (STAT102)**
- **Financial Accounting (ACCT101)**
- **Management Accounting (ACCT102)**
- **Finance (FNCE101)**
- **Linear Algebra and Regression (QF201)**
- **Differential Equations (QF202)**
- **Real Analysis (QF203)**
- **One elective of** *

Probability and Finance Theory (QF204) or Stochastic Processes and Modelling (STAT306) or Risk Theory and Loss Models (STAT311)

- **One elective of**

Computer Technology for Finance (QF205) or Software Foundations (IS200) or Object Orientated Application Development (IS201) or Data Management (IS202) or Software Engineering (IS203)

- **Structured Finance (QF301)**
- **Investment and Financial Data Analysis (QF302) ***
- **Stochastic Calculus and Finance Theory (QF303) ***
- **Numerical Methods (QF304) ***
- **Global Financial Risk Management (QF305)**

  * = advanced undergraduate level

QF 201 Linear Algebra and Regression

- Matrices (including matrix operations, inversion)
- Systems of linear equations (including their solutions by Gauss elimination and matrix operations)
- Determinants, co-factors, Cramer's rule, Euclidean space, general vector spaces, sub-spaces, linear independence
- Norms, Inner, Outer products, Orthogonal bases, Gram-Schmidt orthogonalization
- Eigenvalues, eigenvectors, eigenspaces, eigenbases
- Quadratic forms, positive definiteness
- Least squares solution
- Applications
- Functional language programming: MatLab and Excel VBA

QF 202 Differential Equations

- Solution methods for specific first-order differential equations and higher-order linear differential equations with constant and variable coefficients
- Solution methods for systems of linear first-order differential equations
- Numerical methods e.g. Euler's method, Runge-Kutta method
- Analytical and numerical solutions to the Black-Scholes partial differential equation
- Programming languages: MATLAB, Excel VBA and Maxima

QF 203 Real Analysis

- Foundational mathematical concepts
- Basics of differentiation and integration
- Notions of numbers
- Sets
- Functions
- Sequences
- Limits
- Continuity
- Differential and integral calculus

QF 204 Probability and Finance Theory

Mathematical analysis of probability theory rather than statistical aspects

- Distribution Theory, Conditional Probability and Conditional Expectation
- Modeling state space securities under market equilibrium
- Martingale, Equivalent Martingale Measures, Fundamental Theorems of Asset Pricing
- Change of Numeraire and Discounting, Risk-Adjusted and Forward-Neutral Measures,
- Minimal and Maximal prices of contingent claims
- Markovian Models, and Existence of martingale measures preserving the Markov property
- Discrete Stochastic Calculus and Multiperiod Models leading to no-arbitrage pricing of contingent claims
- Theory of risk aversion and utility, risk premia
- Theory of Markov Chains, Applications in Credit Modeling
- Measure-Theoretic Probability, Moments, Characteristic Functions
- Inequalities, and Central Limit Theorems
- Optimal Consumption and Investment Problems
- Interest Rate Theory
- Construction of Brownian motion

QF 205 Computer Technology for Finance

Use of computing technology in the realm of finance

- Collation of financial data e.g. stock, futures, indexes, currency, interest rate, economic data
- Analysis of data for patterns
- Presentation and visualization of information
- Programming live-feed data
- Trading decision-making

QF 301 Structured Finance

- Basic background to derivatives pricing
- Forwards
- Futures
- Options
- Bonds
- Swaps
- Structured products e.g. CDS, CDO, structured bons
- Current market views

  * about 6 lectures given by practitioners from banks

QF 302 Investment and Financial Data Analysis

Provides fundamental domain knowledge in financial investment theory, in econometrics modeling, and in empirical analyses

- Return Distributions
- Simple Linear Regression and Hedging
- Capital Asset Pricing Model
- Cost of Capital
- Time Series Models
- Market Efficiency and Random Walk
- Predictability of Stock Returns
- Event Studies
- Multiple Linear Regression
- Time Effect Anomalies
- Specification Errors
- Mutli-Factor Asset Pricing Model
- Exchange Rates and risk premia
- Unit Root Processes and PPP
- Conditional Heteroskedasticity

QF 303 Stochastic Calculus and Finance Theory

Introduce students to the mathematics of financial derivatives
Continuous time perspectives

- No-arbitrage principle
- Ito calculus
- Girsanov theorem
- Feynman-Kac theorem
- Concepts of arbitrage and risk-neutral pricing in the context of multi-period asset pricing models
- Use of Markov processes
- Martingales, filtration concepts, stopping times in American options
- State price density, martingale representations theorem
- Term structure theories
- Application problems in exotic derivatives pricing

QF 304 Numerical Methods

- Building recombining and non-recombining trees
- Sampling schemes
- Variance reduction techniques
- Monte Carlo and other simulation methods
- FFT
- Hedge computations involving Greeks
- Implied volatilities
- Calibration methods
- Application problems in derivatives and portfolio risks
- Functional language programming: MatLab and Excel VBA

QF 305 Global Financial Risk Management

Understanding Global financial risks

- Basel principles and standards for the management of the key types of risks faced by commercial banks: Market Risk, Credit Risk, and Operational Risk

- The Basel II framework of the three pillars, namely the determination of minimum capital requirements, the supervisory review process, and market discipline

- Discussing different statistical methods to evaluate VAR

- Review of some of the fundamental concepts in risk management for commercial banks

- Bank management and risk measurements of derivatives and portfolios