



Certificate in Financial Engineering CFE

CFE Course is delivered over 16 days of classroom instructions and self-study stretching between 12 to 18 months of study. The Course is currently delivered in Hong Kong, Singapore, London, New York and Mumbai. All students attending this course either takes the CFE Exam (both Level 1 and Level 2) or makes two detailed thesis / project presentations to qualify for the CFE Certificate.

CFE Course is also delivered Online, via internet for those who want to prepare for the CFE Exam to qualify for the CFE Certificate.

CFE Exam is specially designed for those who do not or cannot enroll and attend the full CFE Course but are desirous of obtaining the CFE Certificate.

The curriculum for both the CFE Course and the CFE Exam is same.

CFE Level 1 Exam: Twice a year in June and Dec

CFE Level 2 Exam: Once a year in Nov / Dec



Richard Kendrick
Market Risk Management
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CFE Graduate & CFE Committee Member

CFE Course Curriculum Topics

- I. Applied and Financial Mathematics
- II. Stochastic Models in Finance (Equity, Interest Rate, FX and Commodity Models)
- III. Numerical Methods in Finance (Option & Derivatives Valuation)
- IV. Financial Products & Product Engineering
- V. Volatility & Correlation
- VI. Options & Financial Derivatives Valuation (Closed form solutions & Analysis)
- VII. Options trading
- VIII. Portfolio Analysis and Asset Allocation (including Algorithmic Trading)
- IX. Risk Management (Market & Credit Risk Modeling)
- X. Excel™/VBA spreadsheet modeling

Excel™/VBA RAD Environment

CFE Course is delivered totally in Excel™/VBA spreadsheet rapid application development (RAD) environment and all – each and every – topics mentioned below in the Curriculum are implemented on Excel™ spreadsheet. Similarly, CFE Level 2 Exam is also administered in an Excel™/VBA RAD environment and even though the questions are multiple choice format, a student would need to make extensive use of Excel™ spreadsheet modeling and working with Excel™ to answer most of the questions.

Broad Indicative Curriculum for Classroom Implementation

- Notes:** (i) *This is only a broad indicative curriculum and the list of topics contained here may not be exhaustive. While most questions in the exam may be asked from these topics, there is no guarantee that all questions will be set from the following curriculum topics.*
- (ii) *All topics contained in this curriculum, including those in Module I (Applied & Financial Math) should be read and understood within the context of real life problem solving in quantitative finance.*

Advanced Quant Finance Topics (Excel™/VBA Tutorials)

- Valuation of Vanilla Options using Fourier Transforms
- Valuation of Passport Options using Stochastic Control Theory
- Application of Principal Components Analysis (PCA) in:
 1. Developing equity trading algorithms
 2. For modeling Interest Rates and FX, Volatility
- Pricing of Best of, Worst of Options using Jump Diffusion Models
- Valuation of Options using Kou's Double Exponential Jump models
- Pricing and calibration of Commodity Derivatives using mean reverting OU Process.

- Implementing Gaussian Quadrature methods for derivatives valuation and numerical schemes for pricing basket options using double integral.

I. Applied and Financial Mathematics

Stochastic calculus, Weiner process, random Walk, Brownian motion, first exit times, stopping times, arc sine law, probability distributions (Gaussian, Poisson, Gamma, etc.), foundations of measure theory, differential and integral calculus, matrices and matrix theory, differential equations, Fourier and Laplace transforms, linear and non-linear optimization, solution of non-linear equations, root finding,

II. Applications of Matrices in Finance

Solution of system of linear equations: (applications to option portfolio, Vanna-Volga weight calculation, etc.), variance-covariance matrix calculation from market data, VaR estimation, estimation of bond returns with default and transition matrices, mean-variance optimization, optimization and asset allocation problems, risk minimization and other applications in algorithmic / quantitative trading, credit risk loss modeling, random matrices and application to portfolio analysis.



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III. Stochastic Models in Finance (Modeling Equity, Interest Rate, FX, Commodities & Volatility)

Stochastic Process and a Markov Process, Random Walk, Geometric Brownian motion, Reimann Zeta Function and the Brownian motion, Brownian motion for the Inverse of the Asset Price, Brownian motion with default, Stochastic Process for the Relative Process of Two Assets, Arithmetic Brownian motion, Mean Reverting Brownian motion, Brownian Bridge Process, Cox-Ross Square Root Process, Ornstein-Uhlenbeck Process, Vasicek Process, Cox-Ingersoll-Ross Process, Black Derman Toy (BDT) Process, Black Karisinski Process, Poisson Jump Diffusion Process, Kou's Double Exponential Process Heston Stochastic Volatility Model, Heston-Nandi GARCH model, Double Mean Reverting Process for Variance, Constant Elasticity of Variance (CEV) Process, Stochastic Alpha Beta Rho (SABR) Model, Longstaff's Double Square Root Model, Stochastic Local Volatility (SLV) Process, SLV Bloomberg Model, GARCH Diffusion Process, Gibson & Schwarz Stochastic Convenience Yield Process, Stochastic Correlation Process, Mixture of Normals Process, Variance Gamma (VG) Process, Monte Carlo Simulation for VG Process, Displaced Diffusion Model, Libor Market Model (LMM), BGM Model, Heath Jarrow Morton (HJM) model, Homogenous Poisson Process, Monte Carlo Simulation for Valuation of Single Asset options, Multi-asset Stochastic Process, Cholesky Decomposition, Eigenvalue decomposition, Monte Carlo Simulation of Valuation of Multi-asset options, Cleaning Correlation Matrices, Quantum Random Walk.



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IV. Numerical Methods in Finance (For Valuation of Financial Derivatives)

Note: This module needs extensive and advanced applications of Excel™ spreadsheets, Excel™ codes and some amount of VBA coding.

Monte Carlo simulation methodology, simulating a random walk and a Brownian motion, simulating other stochastic processes as given in Module III above, Cholesky and Eigenvalues decomposition, simulating multi-asset stochastic processes, variance reduction techniques, generating pseudo and quasi random numbers, Cox-Ross-Rubenstein (CRR) tree and other kinds of binomial trees, CFE trinomial trees and other kinds of trinomial trees, numerical integration routines, trapezoidal and other rules for numerical integration Gaussian Quadrature Methods, solution of Black-Scholes equation using Green's function, finite difference methods, forward difference and Crank-Nicholson method, implementation of Fourier transforms and fast Fourier transforms (FFT).

V. Financial Products and Product Engineering

Vanilla Options, Straddles and zero beta straddles, Binary Options, Outperformance Digital options, Money back options, Fixed and Floating Strike Lookback Options, Arithmetic Average Options, Chooser Options, Symmetric and Asymmetric Power Options, Forward Starting and Cliquet Options, Reverse Cliquet Options, Napoleon Options, Exchange Options, Amortizing Options, Pyramid and Madonna Options, Basket Options, Best of and Worst of Options, Himalaya, Altipano and Everest Options, Capped Bull Note, Principal Protected Bull Note, Principal Protected Bear Note, Principal Protected Mixed Note, Equity Linked Basket Note, Note with a Short Put option embedded, Perpetual Capped Call Note (American style) with no maturity,



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Accumulators, Target Redemption notes (TARN), Equity Linked Savings, Equity linked barrier, digital and lookback notes, chooser notes and notes with Asian tail, fixed income floating rate notes (FRN), inverse FRNs, CMS linked notes, inflation linked notes, Decomposition of Structured Product through Payoff Diagram, Convertible Bonds and Reverse Convertible Bonds, Caplet and Snowball options, Sycurve Options, Compound options, Installment options, Israeli options, Timer options.

VI. Volatility and Correlation

Implied Volatility

Numerical Estimation of Implied Volatility, Leland's Formula, Brenner-Subrahmanyam Approximations, Corrado Miller Approximation, Steven Li's Approximation, SABR Volatility, CEV Volatility, Volatility Skew, Implied Volatility Surface and Interpolating Implied Volatility, Vanna Volga Methodology, Local Volatility, Local Volatility in presence of default and jumps;

Historical Volatility

Historical Volatility using close to close price, Parkinson's Number, Garman-Klass Estimator, EWMA Volatility, GARCH Process

Stochastic Volatility

Heston's stochastic volatility model: closed form implementation using complex integrals, Heston-Nandi GARCH model implementation, evaluation of Greeks in Heston and Heston-Nandi model, Full valuation of Heston and Heston-Nandi models using Monte Carlo simulation (*refer to Module III: Stochastic Models in Finance*).

Model Free Volatility and Variance Swaps

Log Contract, Britten-Jones & Neuberger Model, Variance Swap, VIX Index, Volatility Swap, Correlation and Implied Correlation, Correlation Skew, Dispersion



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Derivatives Specialist
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VII. Options and Financial Derivatives Valuation (Closed Form solutions and Analysis)

Vanilla Options using Black-Scholes Model, Put-Call Parity and Put-Call Symmetry, Straddle Options, Option pricing using Displaced Diffusion model, Power Option, Exchange Option, Binary Option, Barrier Option, One Touch Option, Double Barrier (Binary) Option, Fixed and Floating Strike Lookback options, Arithmetic Average option, Forward Starting option, Caps and Floors, Swaption Valuation using Black's formula, SYCURVE Options, Bond Option pricing using Black's formula, Options on Zero Coupon Bond using Vasicek's Model, Options on Variance.

Greeks

Call and Put Delta, Call and Put Gamma, Vega of Options, Hedging Error due to Volatility Smile, Theta and Rho of Vanilla options, Binary Call and Put Delta, Dirac Delta Function and the Binary, Binary Gamma and Vega, Variance Swap Greeks, Greeks for barrier options and other exotic options, estimation of Greeks using numerical methods, using Greeks for hedging option books,

VIII. Options Trading

Market making and proprietary trading, liquidity and liquidity holes, trader's edge and Dubins Savage theorem, delta hedging, lock delta, partial and total delta, managing gamma and shadow gamma, moments of option position, bucketing and topography, modified vega analysis, understanding fat tails, orders of volatility trade (first order, second order and higher order volatility trades), managing a book of binary and barrier options, using straddles, strangles and risk reversals, vanna-volga overhedge, price-volatility matrix and analyzing vega convexity.



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IX. Portfolio Analysis & Asset Allocation (Including Algorithmic Trading)

Sharpe Ratio, Treynor Ratio and Jensen's Alpha, Portfolio Volatility, Expected Return for Stocks and Bonds, Volatility of Spreads, Probability of Stocks Outperforming Bonds, Mean-Variance Optimization for a Total Return Objective, Mean-Variance Optimization by maximizing Sharpe Ratio, Sharpe's Algorithm for Efficient Frontier, Portfolio Insurance, Constant Proportion Portfolio Insurance (CPPI), Capital Asset Pricing Model (CAPM), Minimization of Risk and MCR Algorithm, Statistical Arbitrage, Triangular Arbitrage, pre-trade and post-trade analysis, market impact and timing risk, Principal bid transactions, efficient trading frontier and advanced trading models, VWAP strategy.

X. Risk Management (Market and Credit Risk Modeling)

Spot and forward risk, parametric VaR estimation, VaR using Monte Carlo simulation, Cornish-Fisher transformation, Portfolio VaR, marginal VaR, Principal Components Analysis (PCA), VaR for equity, bond and FX portfolios, cash flow mapping techniques and application to FX forwards and fixed income products, VaR for options book: delta normal VaR and delta-gamma VaR, Vega VaR, structural approach to predicting default and valuation models, transition matrices and prediction of default and transition rates, Loss given default (LGD), asset value approach and estimation of credit portfolio risk, credit portfolio models and their validations, Basel II and Internal Ratings methodology

XI. Excel™/VBA Spreadsheet Coding & Modeling

Financial functions: NPV, IRR, PMT, XIRR, XNP, Date functions: Now, Today, Date, Weekday, Month, Datedif, Statistical functions: Average, Var, Varp, Stdev, Stdevp, Correl, Covar, Regression functions: Slope, Intercept, Rsq, Linest, Conditional functions: If, VLookup, HLookup, Boolean functions: And, Or, Count, Countif, Offset, Statistical functions: Rand, Normsdist, Normsinv, Skew, Other functions: Large, Small, Rank, Percentile, Count, Countif, Math Functions: Trigonometric functions, Engineering functions, Multiple Regression functions in Excel and making scatter plots, generation of regression equations, Handling arrays and array functions and matrix functions: Transpose, matrix multiplication, inverse of a matrix and determinant, power of a matrix, subtracting a constant from a matrix, using GoalSeek and Solver in Excel: Application & mini tutorial, introduction to VBA Editor and using VBA sub-routines (macros) and user defined functions in Excel spreadsheet (only the use of readymade VBA programs will be demonstrated, no VBA programming will be done), formula Auditing, use of subscripts and superscripts, naming and hiding cells, addition of Greek symbols in an Excel spreadsheet and use of Equation Editor for embedding / writing mathematical formulas (images) in the sheet.

Project Presentation and Thesis Outline

There is a special provision for students who want to make project presentations and a Thesis presentation in the class during the course of study to get exemption from the CFE Level 1 and Level 2 Exam or get credit towards the exam, provided that such project and thesis presentations are of outstanding quality, developed for a particular front or middle office banking or finance application and delivered using using Excel™/VBA.

CFE Course Method of Delivery

- 16 days of classes on weekends (delivered over 12 to 24 months);
- Periodic seminars
- Self-study using course / study materials uploaded via internet on the CFE Online Forum.
- CFE Online is an extensive library and warehouse of content and course materials, including a large repertoire of Excel™ spreadsheet tutorials, risk tools, quantitative model implementations, problems and solutions, etc.