28 - 30 June, 2010
15 – 17 November, 2010
Liverpool Street, London, UK

'Early Bird' Discounts Available

Daniel J. Duffy presents

Advanced Finite Difference Method for Quantitative Finance: Theory, Applications and Computation

This three-day course shows how to use the Finite Difference Method (FDM) to price a range of one-factor and many-factor option pricing models for equity and interest rate problems that we specify as partial differential equations (PDEs). We introduce and elaborate modern and robust finite difference methods that solve pricing problems and that remain stable and accurate for various combinations of input parameters, payoff functions and boundary conditions.

This course discusses all aspects of option pricing, starting from the PDE specification of the model through to defining robust and appropriate FD schemes which we then use to price multi-factor PDE to ensure good accuracy and stability. The contents of the course have been updated and revised to reflect new results and developments in the field.

About the speaker

Daniel J. Duffy has BA (Mod), MSc and PhD degrees, all of which in mathematics and numerical analysis. He has been working with numerical methods on finance, industry and engineering since 1979. He has written four books on numerical methods and C++ for quantitative finance and he has developed a number of new schemes for this field as well as more than 20 years of training experience.

What do you learn?

In general, you learn how to analyse, design and assemble finite difference schemes in computational finance applications. Some of the specific skills that you learn are:

- Define an unambiguous, water-tight PDE for an option model
- Get a real understanding of finite differences, from A to Z
- Know which schemes work and when
- Apply FDM to a wide range of option pricing models
- Learn robust and accurate algorithms
- Guidelines on implementation in C++, C#, parallel and GPUs

In short, you will learn the latest developments in this field and be able to use them immediately in your own work. Source code for the models is provided.

What do you receive?

As attendee you receive a full set of slides, CD with software and a copy of Daniel Duffy's book "*Finite Difference Methods in Financial Engineering: A Partial Differential Equation Approach*". You are invited to ask questions on your own specific applications as well.

The price includes coffee, tea, lunch and refreshments.

What have previous delegates said?

- ***"My expectations were topped; can go now and implement 3d models using splitting"***
- ***"Really liked it. Very informative"***
- ***"I would enthusiastically recommend this course to colleagues"***
- ***"Excellent course"***

Prerequisites

Candidates should have a good background in mathematics and knowledge of financial derivatives.

Who should attend?

This course has been developed so that you can use the theory to solve existing problems as well as applying the knowledge to the pricing of new financial instruments. In particular, the course is for professionals with a strong mathematical background:

- Financial engineers who design new pricing models
- Analysts and quants
- Other professionals who wish to understand and apply advanced numerical methods to derivatives pricing

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Course contents

Part 1- One-Factor Models

General Considerations
- Approximating derivatives by divided differences
- Specifying boundary conditions
- Payoff functions, monitoring points
- Solving the system of equations

Choice of Time Discretization
- Euler, Crank-Nicolson, Rannacher methods
- Alternating Direction Explicit (ADE) method
- Using Bulirsch-Stoer for stiff equations
- Richardson extrapolation

Special Attention Areas and their Resolution
- Discontinuous coefficients
- Extreme (large, small) volatility and drift terms
- Avoiding oscillations in the greeks (for example, at the strike price)
- Spikes in barrier options
- Adaptive meshing

Early Exercise Features
- PDE formulation
- Penalty method
- ADE with the Brennan Schwartz model
- Other methods (front fixing, front tracking, PVI)

Test Cases
- European vanilla option: domain truncation versus domain transformation
- Barrier options and exponential fitting; time-dependent barriers
- American options using the Brennan-Schwartz algorithm
- Robust approximation to the greeks

The Keller Box Scheme
- Reduction of Black Scholes PDE to first-order system
- Accomodating discontinuous payoffs and boundary conditions
- Formulating the box scheme as first-order system
- Achieving second-order accuracy in price and delta

Special Topics
- Mollifiers and smoothing of payoff functions
- Conservative versus non-conservative PDE forms; which one?
- Modelling transity density and Fokker-Planck equation
- Calibration

Part 2 Two-Factor Models

Some Partial Differential Equations for two Factors
- Asian options
- Basket options
- Heston model
- Black Scholes model with stochastic interest rates

Analysing Multi-factor PDEs
- The Fichera theory and non-negative characteristic forms in finance PDEs
- Using Fichera theory to deduce and discover boundary conditions
- The relationship between Fichera function and the Feller condition for Heston and CIR models
- Fichera function and domain transformations

The ADI Method
- Using ADI for two-factor PDE
- Mixed derivatives using Craig-Sneyd and Hout/Welfert
- Test cases: basket options and Heston model
- Generalising the ADI method

The Operator Splitting Method
- Yanenko, Marchuk and Strang splittings
- Explicit and implicit splitting
- Handling mixed derivatives and boundary conditions
- Splitting and predictor-corrector methods
- Example: baskets, Heston, SABR PDEs

The ADE Method
- Origins and background; how it differs from ADI and splitting
- Motivating ADE: from heat pde to convection-diffusion and mixed derivatives
- One-sided and centred variants of ADE
- ADE in 3 and more factors
- ADE and how it is parallelised

Comparing ADI, Splitting and ADE Methods
- How they handle mixed derivatives
- Boundary conditions
- Accuracy and robustness of the schemes
- Improving accuracy
- Can the scheme be parallelized?

Mixed Derivatives
- Modeling correlation: extreme cases
- Craig-Sneyd, Verwer, Hout_Welfert, Yanenko
- Stress-testing mixed derivatives
- Test case: compare ADI, splitting and ADE for Heston model

Advanced Techniques
- Coordinate and domain transformation
- Adaptive meshing
- Mixed PDE-Monte Carlo method
- Random walk in a PDE
- Transition density computation using ADE

Part 3 Three-Factor, Hybrid and Interest Rate Applications

An Introduction to Three-Factor Modelling
- Model: the 3d Heat equation and Poisson's equation
- Comparing ADE and splitting methods
- Creating a reusable baseline software structure for computational finance
- Parallelisation and speedup

Modelling Jumps
- Merton's and Kou model
- Partial Integro-Differential Equations (PIDE)
- Finite Difference Methods for PIDE
- An Introduction to the Finite Element Method (FEM) for PIDE

Interest-rate Models and PDE/FDM
- One-factor models (Vasicek, CIR, Hull-White)
- Comparing domain truncation and domain transformation
- Recovering the Feller condition
- Problem schemes; challenges and solutions
- Using the ADE method for one-factor IR models

Three-Factor PDEs and FDM Solutions
- Multi-asset (basket) options
- Hull-White-Heston model
- Numerical solution of 3-factor models
- Multiple mixed derivative terms
- Libraries, design and object-oriented solutions

Further Information

Dates: 3 Days
28 – 30 June, 2010
15 – 17 November, 2010

Venue: Liverpool Street, London, UK
Cost: £3000 exc. VAT

Registration
Please Return Application form to:

Financial Training
MoneyScience Ltd
4 St Pauls Road
Bristol
BS8 1LT
UK

Enquiries:

Jacob Bettany

Tel: +44 (0) 117 923 8851
Email: jacob@moneyscience.com

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Advanced Finite Difference Method for Quantitative Finance: Theory, Applications and Computation - Registration Form

This form relates to participation on ☐ June 29 – 30 ☐ November 15 -17

Title:	
First Name:	
Last Name:	
E-mail address:	
Participant's First Name (If different from above):	
Participant's Last Name (If different from above):	
Participant's E-mail address (If different from above):	
Position:	
Telephone:	
Company Name:	
Tax Registration No:	
VAT Identification No:	
Department:	
Address:	
Town:	
State:	
Postal Code:	
Country:	
How did you hear about this course?	
Comment or requirements	

Please Return Completed Application to:

Financial Training,
MoneyScience,
4 St Pauls Road,
Bristol, BS8 1LT, UK

or Sign, Scan and Return to jacob@moneyscience.com

SIGNED..

DATE..

☐ **I have read and understand the Terms and Conditions on the page following.**

Cancellation

If a person which has registered for this course is unable to attend for whatever reasons, a substitute representative may be appointed to participate in advance. Cancellation will be accepted only in written form no later than twenty calendar days prior to the date of the course while a cancellation fee in the amount of 10% of the price or block price will be charged. Cancellation of the participation within a period of less than twenty calendar days prior to the date of the course is not possible for the technical and the organisational reasons. MoneyScience reserve the right at all times to cancel participation or cancel the entire seminar for whatever unspecified reasons, including possible force majeur. In this case, the price will be refunded in full to the applying participant.

Terms and Conditions:

MoneyScience Training Events are English-language seminars, training sessions and practical workshops delivered by expert, qualified tutors. Our objective is to provide industry professionals with advanced financial know-how and up-to-date analytical methods and skills.

Tuition Language

MoneyScience Events are held in English and all relevant manuals, training software etc. are also provided in English. In order to benefit from participation, a good working knowledge of English, including common financial phrases and related terminology, is required.

Registration

Clients who decided to participate, should submit their registration by mail to us in advance. Subject to availability, the participant will then receive a confirmation of participation. The number of participants is strictly limited to preserve an effective and focused learning environment.

Seminar Prices

The quoted seminar prices are per person and include all course material, lunches and refreshments, The price does not include hotel accommodation. Quoted prices are exclusive of VAT.

Discounts

Bulk discounts are offered when submitting an application for the participation of more than one person. Please contact jacob@moneyscience.com for further details.

Invoicing and Payment

An invoice for the seminar price will be sent to the participants on receipt of their Registration Form and should be paid within days. Full payment of the invoice must be made before the start of the course as a precondition of participation.

Terms of Cancellation

If for whatever reasons a registered participant is unable to attend, a substitute delegate may be appointed to participate instead. For cancellations received 20 days or more before the beginning of the seminar, a 10 % cancellation fee of the full price will be invoiced i.e. 90 % of the price is refunded. For cancellations received less than 20 days prior to the beginning of the seminar, the full price is payable i.e. no refund will be provided. All cancellations must be in writing. MoneyScience reserves the right to cancel the individual participation or cancel the entire seminar or part of it for whatever unspecified reasons, including possible force majeure. In this case, the price paid will be refunded in full or in part, accordingly.