

**Subject ST6
Finance and Investment
Specialist Technical B**

Syllabus

for the 2008 Examinations

1 June 2007

**The Faculty of Actuaries and
Institute of Actuaries**

Subject ST6 — Finance and Investment Specialist Technical B Syllabus

Aim

The aim of the second finance and investment technical subject is to instil in successful candidates the ability (at a higher level of detail and ability and detail than in CT8) to value financial derivatives, to assess and manage the risks associated with a portfolio of derivatives, including credit derivatives and to value credit derivatives using simple models for credit risk.

Links to other subjects

This subject develops concepts introduced in Subject CT8 — Financial Economics, particularly objectives (vii), (viii) and (ix) of this syllabus.

Subject CA1 — Core Application Concepts: covers the general underlying principles affecting all specialisms.

Objectives

On completion of this subject the candidate will be able to:

- (a) Show an awareness of the basic characteristics of the derivatives markets.
 - (i) Define and describe exchange traded contracts and over-the-counter contracts.
 - (ii) Describe the payoffs of forwards and futures, calls and puts (American and European).
 - (iii) Describe the uses of forwards, futures and options by hedgers, speculators and arbitrageurs.
 - (iv) Demonstrate an understanding of how futures markets work.
- (b) Demonstrate a knowledge of forward and future prices.
 - (i) Derive forward and future prices by no-arbitrage, on:
 - a non-dividend paying stock
 - a dividend-paying stock
 - a stock index
 - a foreign currency
 - an investment commodity
 - a consumption commodity

- (ii) Define the following:
- investment commodity
 - consumption commodity
 - cost of carry
 - convenience yield
 - storage costs
- (c) Show an awareness of the role of futures in hedging.
- (i) Describe how to use futures contracts defined in (b) for hedging.
- (ii) Define what is meant by basis risk and its impact on hedging strategies.
- (d) Define and describe the following traded derivative contracts:
- stock options
 - currency options
 - index options
 - options on futures
 - warrants
 - convertibles
 - over-the-counter options
- (e) Define and describe the following interest rates, and interest-rate derivatives:
- Treasury Rates, LIBOR Rates, Repo Rates
 - Zero Rates
 - Forward Rates
 - Forward Rate Agreements
 - Interest Rate Futures
 - Treasury Bond Futures
 - Interest Rate Swaps
 - European Swap Options (swaptions)
 - Caps and caplets
 - Floors and floorlets
 - Bermudan swaptions
- (f) Describe the following exotic equity and foreign exchange derivatives:
- Quanto options
 - Chooser options
 - Barrier options
 - Binary options

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- Lookback options
 - Asian options
 - Exchange options
 - Basket options
- (g) (i) Describe how the following factors affect option prices:
- stock price
 - strike price
 - term to expiry
 - volatility
 - risk-free rate
 - dividends
- (ii) Draw simple charts to illustrate these effects.
- (h) Demonstrate a knowledge and understanding of the mathematics underpinning the pricing and hedging of derivative instruments.
- (i) Demonstrate a knowledge and understanding of the theory underpinning the calculation of derivative prices and their hedging strategies using the binomial model including:
- sample paths
 - filtrations
 - the Binomial Representation Theorem
 - conditional expectations
 - previsible process
 - self-financing portfolio strategies
 - replicating strategies
 - pricing under the martingale measure
- (ii) Demonstrate a knowledge and understanding of the theory underpinning the calculation of derivative prices and their hedging strategies using the Black-Scholes model including:
- Brownian motion
 - Ito calculus
 - Ito's formula
 - Statement of the Cameron-Martin-Girsanov Theorem
 - The concept of the Radon-Nikodym derivative
 - Change of measure
 - Statements of the Martingale Representation Theorem
 - Continuous-time portfolio strategies

- Self-financing portfolios in continuous time
 - The Black-Scholes model
 - Construction of replicating strategies using the martingale approach
 - The Black-Scholes formula for non-dividend paying stocks
- (iii) Show how to adapt the martingale approach to the pricing of foreign-exchange options and options on stock indexes paying dividends continuously.
- (iv) Derive the Black-Scholes-Merton partial differential equation.
- (v) Demonstrate an understanding of the role of the market price of risk in the transfer between the real-world and the risk-neutral probability measures
- (vi) Describe how the Black-Scholes pricing formula can be used to determine implied volatility.
- (vii) Describe approaches to valuing options of discrete dividend paying securities
- (viii) Describe the following numerical methods for calculating equity and foreign exchange derivative prices and hedging strategies: finite differences, Monte Carlo techniques, lattices.
- (ix) Demonstrate an awareness of the problems in pricing American options and describe the following methods of calculation:
- Binomial and trinomial trees
 - Monte-Carlo simulation using the Least-Squares (Longstaff-Schwartz) approach
- (i) Demonstrate a knowledge and understanding of how to hedge individual derivatives and portfolios of derivatives.
- (i) Demonstrate an understanding of the concept of delta-hedging and show how to apply it.
- (ii) Calculate the partial derivatives (the Greeks) and discuss their use in hedging.
- (iii) Demonstrate the way in which option prices and Greeks change in relation to underlying variables.
- (iv) Describe how the Greeks are used in the risk management of a portfolio of derivatives.
- (v) Describe the role of futures contracts in the risk management of a portfolio of derivatives.

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- (vi) Derive the partial derivatives described above for Black-Scholes European option prices and describe their general characteristics.
 - (vii) Describe how to manage portfolios of derivatives using scenario analysis.
 - (viii) Understand the risk management characteristics of certain exotic products (e.g. foreign exchange or equity barrier options).
- (j) Demonstrate a knowledge and understanding of interest rate derivatives and the Black model.
- (i) Calculate, and explain how to calculate:
 - the yield curve, zero rates, forward rates and bond prices
 - the relationship between forward rates and futures rates
 - the value of interest rate swaps
 - (ii) Describe the relationship between swap quotes and LIBOR zero rates.
 - (iii) Demonstrate a knowledge and understanding of the use of the Black model for pricing and valuing the following contracts:
 - Options on futures contracts
 - Caps and floors
 - European swap options (swaptions)
 - (iv) Comment on the assumptions underlying Black's model.
 - (v) Describe the hedging of interest rate derivatives with respect to the underlying parameters (the Greeks).
- (k) Demonstrate a knowledge and understanding of models of the term structure of interest rates.
- (i) Describe the Hull & White model for the term-structure of interest rates and contrast this with the Vasicek and Cox-Ingersoll-Ross models.
 - (ii) Show an understanding of the numerical techniques used to value an interest-rate derivative using the risk-neutral approach to pricing.
 - (iii) Be aware of valuation methods of an interest-rate derivative using an appropriate Forward Measure and Zero-coupon bond.
 - (iv) Demonstrate an understanding of the role of the market price of risk in the dynamics of the Vasicek and Cox-Ingersoll-Ross models.

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- (v) Describe how interest-rate models can be developed in a multifactor setting.
 - (vi) Demonstrate an understanding of the characteristics of the LIBOR Market Model and Swap Market Model and show how they can be used to price caps and swaptions.
 - (vii) Demonstrate how Black's model can be used to calibrate the LIBOR and Swap Market Models, and discuss the problems with this approach.
- (l) Demonstrate an awareness of the characteristics of different types of structured derivatives and synthetic securities that can be encountered in actuarial work.
- (i) Define the following securities and OTC contracts and describe how each can be used to hedge certain types of liability:
 - Gilt STRIPS
 - Interest-rate swaps
 - Interest-rate swaptions
 - Index-linked gilts
 - Inflation swaps
 - Limited Price Indexation (LPI) swaps
 - LPI bonds
 - (ii) Describe how non-economic risks such as longevity risk can be hedged using suitable index-linked securities and OTC contracts.
 - (iii) Describe how the following issues affect the suitability of traded securities and OTC contracts for liability hedging:
 - Basis risk
 - Capital structure
 - Credit risk
 - (iv) Describe how special purpose vehicles can be used as part of a mechanism for risk transfer, including the role of a credit enhancement agency.
- (m) Identify the credit risks and market risks that arise in the use of derivatives.
- (i) Define market risk.
 - (ii) Define credit risk and describe the conditions necessary for a credit loss to occur.
 - (iii) Outline the nature of the risks associated with the use of derivatives and how these may be handled.

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- (iv) Demonstrate an understanding of simple techniques for measuring credit risk on derivatives.
- (v) Outline possible methods for establishing value at risk (on a portfolio).
- (vi) Demonstrate a knowledge and understanding of the following types of credit derivatives:
 - Credit default swaps (CDS's)
 - *N*th to default baskets
 - Collateralised debt obligations (CDO's)
- (vii) Demonstrate an awareness of the relationship between CDS's and corporate bonds, in particular as shown by their relative credit spreads.
- (viii) Describe how credit derivatives can be used to manage the credit risk present in a portfolio of securities.
- (ix) Show an awareness of the role of correlation in pricing credit derivatives.

End of Syllabus