Institute
and Faculty
of Actuaries

Subject ST6
Finance and Investment
Specialist Technical B

Syllabus

for the 2018 exams

1 June 2017

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 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 – Actuarial Risk Management: 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.

(v) Describe the operation of central counterparty clearing houses (CCPs) and the related regulatory environment.

(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
- property derivatives

(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

- 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) Demonstrate an understanding of the role of the volatility parameter in the valuation of options, including:

- calculation of implied volatility from option prices
- estimation of volatility from historical time series or other market indices (e.g. the VIX index)
- the "smile" effect and volatility surfaces

(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 derivatives.

(i) Calculate the partial derivatives (the Greeks) and discuss their use in hedging individual derivatives and portfolios of derivatives.

(ii) Demonstrate the way in which option prices and Greeks change in relation to underlying variables.

(iii) Describe how to manage portfolios of derivatives using scenario analysis.

(iv) 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 and changes of numeraire in the dynamics of term structure models.

(v) Describe how interest rate models can be developed in a multifactor setting.

(vi) Demonstrate an understanding of the characteristics of the Heath, Jarrow and Morton (HJM) and LIBOR market models and show how the LIBOR market model can be used to price caps and swaptions.

(vii) Demonstrate how Black's model can be used to calibrate the LIBOR market model, 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:

- STRIPS
- Interest rate swaps
- Interest rate swaptions
- Index-linked bonds
- 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 market, credit (or counterparty) and liquidity risks that arise in the use of derivatives.

(i) Define market risk, credit (or counterparty) risk and liquidity risk.

(ii) Outline the way in which these risks affect the use of derivatives and how these risks may be handled.

(iii) Demonstrate an understanding of the use and limitations of credit ratings.

(iv) Demonstrate an understanding of simple techniques for measuring and managing credit (or counterparty) risk on derivatives, including International Swaps and Derivatives Association (ISDA) agreements and collateral management.

(v) Outline possible methods for establishing Value at Risk (on a portfolio).

(n) Demonstrate a knowledge and understanding of credit derivatives and their application.

(i) Demonstrate a knowledge and understanding of the following types of credit derivative:

- Credit default swaps (CDS's)
- *N*th to default baskets
- Collateralised debt obligations (CDO's)
- Total return swaps

(ii) Demonstrate an awareness of the relationship between CDS's and corporate bonds, in particular as shown by their relative credit spreads.

(iii) Describe how credit derivatives can be used to manage the credit risk present in a portfolio of securities.

(iv) Show an awareness of the role of correlation in pricing credit derivatives.

END OF SYLLABUS