

# Subject CM2

## 2023 Study Guide

### Introduction

This Study Guide has been created to help you navigate your way through Subject CM2. It contains all the information you will need before starting to study Subject CM2 for the 2023 exams and you may also find it useful to refer to throughout your studies.

The guide is split into two parts:

- Part 1 contains specific information about Subject CM2.
- Part 2 contains general information about the Core Principles subjects.

**Please read this Study Guide carefully before reading the Course Notes**, even if you have studied for some actuarial exams before. While you may have already read (the majority of) the Part 2 material in previous subjects, the information in Part 1 is unique to this course.

### Contents

<b>Part 1</b>	Section 1	Subject CM2 – background and contents	Page 2
	Section 2	Subject CM2 – Syllabus and Core Reading	Page 4
	Section 3	Subject CM2 – summary of ActEd products	Page 13
	Section 4	Subject CM2 – skills and assessment	Page 14
	Section 5	Subject CM2 – frequently asked questions	Page 15
<b>Part 2</b>	Section 1	Before you start	Page 16
	Section 2	Core study material	Page 18
	Section 3	ActEd study support	Page 20
	Section 4	Study skills and assessment	Page 28
	Section 5	Queries and feedback	Page 34

## 1.1 Subject CM2 – background and contents

### History

The Actuarial Mathematics subjects (Subjects CM1 and CM2) were introduced in the Institute and Faculty of Actuaries' 2019 Curriculum.

Subject CM2 is *Financial Engineering and Loss Reserving*.

### Predecessors

The topics in the Actuarial Mathematics subjects cover content previously in Subjects CT1, CT5, CT8 and a small amount from Subjects CT4, CT6 and CT7:

- Subject CM1 contains material from Subjects CT1, CT4 and CT5.
- Subject CM2 contains material from Subjects CT8, CT6, CT1 and CT7.

### Exemptions

In order to be eligible for a pass in Subject CM2, you will need:

- to have passed or been granted an exemption from Subject CT8 during the transfer process
- to have met the Institute and Faculty of Actuaries' requirements based on the current curriculum.

See the Institute and Faculty of Actuaries' website for further details:

**[actuaries.org.uk/studying/exam-exemptions](https://actuaries.org.uk/studying/exam-exemptions)**

### Links to other subjects

Concepts introduced in the following subjects are used in Subject CM2:

- CS1 – Actuarial Statistics 1
- CS2 – Risk Modelling and Survival Analysis
- CM1 – Actuarial Mathematics 1
- CB2 – Business Economics.

Topics in Subject CM2 are further built upon in the following subjects:

- Subject CP1 – Actuarial Practice
- CP2 – Modelling Practice
- SP5 – Investment and Finance Principles
- SP6 – Financial Derivatives Principles
- SP9 – Enterprise Risk Management Principles.

## Contents

There are four parts to the Subject CM2 course. The parts cover related topics and are broken down into chapters. At the end of each part there are assignments testing the material from that part.

The following table shows how the parts and chapters relate to each other. The final column shows how the chapters relate to the days of the regular tutorials. This table should help you plan your progress across the study session.

Part	Chapter	Title	No of pages	X Asst	Y Asst	Tutorial – 4 full days
1	1	The Efficient Markets Hypothesis	23	X1	Y1	1
	2	Utility theory	48			
	3	Stochastic dominance and behavioural finance	28			
	4	Measures of investment risk	33			
	5	Stochastic models of investment returns	33			
	6	Portfolio theory	40			
2	7	Models of asset returns	30	X2	Y1	2
	8	Asset pricing models	30			
	9	Brownian motion and martingales	33			
	10	Stochastic calculus and Ito processes	47			
	11	Stochastic models of security prices	17			
	12	Characteristics of derivative securities	48			
3	13	The Greeks	18	X3	Y2	3
	14	The binomial model	66			
	15	The Black-Scholes option pricing formula	42			
	16	The 5-step method in discrete time	37			
	17	The 5-step method in continuous time	51			
4	18	The term structure of interest rates	40	X4	Y2	4
	19	Credit risk	44			
	20	Ruin theory	80			
	21	Run-off triangles	72			

## 1.2 Subject CM2 – Syllabus and Core Reading

### Syllabus

The Syllabus for Subject CM2 is given here. To the right of each objective are the chapter numbers in which the objective is covered in the ActEd course.

#### **Aim**

The aim of the Financial Engineering and Loss Reserving subject is to provide a grounding in the principles of modelling as applied to actuarial work – focusing particularly on stochastic asset liability models and the valuation of financial derivatives. These skills are also required to communicate with other financial Institute and Faculty of Actuaries and to critically evaluate modern financial theories.

#### **Competences**

On successful completion of this subject, a student will be able to:

1. describe, interpret and discuss the theories on the behaviour of financial markets.
2. discuss the advantages and disadvantages of different measures of investment risk.
3. describe, construct, interpret and discuss the models underlying asset valuations.
4. describe, construct, interpret and discuss the models underlying liability valuations.
5. describe, construct, interpret and discuss the models underlying option pricing.

#### **Syllabus topics**

- |    |  |       |
|----|--|-------|
| 1. | Theories of financial market behaviour | (15%) |
| 2. | Measures of investment risk            | (15%) |
| 3. | Stochastic investment return models    | (10%) |
| 4. | Asset valuations                       | (20%) |
| 5. | Liability valuations                   | (20%) |
| 6. | Option theory                          | (20%) |

The weightings are indicative of the approximate balance of the assessment of this subject between the main syllabus topics, averaged over a number of examination sessions.

The weightings also have a correspondence with the amount of learning material underlying each syllabus topic. However, this will also reflect aspects such as:

- the relative complexity of each topic, and hence the amount of explanation and support required for it
- the need to provide thorough foundation understanding on which to build the other objectives
- the extent of prior knowledge which is expected
- the degree to which each topic area is more knowledge or application based.

***Detailed syllabus objectives***

- |    |   |                    |
|----|---|--------------------|
| 1. | Theories of financial market behaviour  | (15%)              |
|    | 1.1 Rational expectations theory  | (Chapter 1)        |
|    | 1.1.1 Discuss the three forms of the Efficient Markets Hypothesis and their consequences for investment management.   |                    |
|    | 1.1.2 Describe briefly the evidence for or against each form of the Efficient Markets Hypothesis.   |                    |
|    | 1.2 Rational choice theory  | (Chapters 2 and 3) |
|    | 1.2.1 Explain the meaning of the term 'utility function'.   |                    |
|    | 1.2.2 Explain the axioms underlying utility theory and the expected utility theorem.  |                    |
|    | 1.2.3 Explain how the following economic characteristics of investors can be expressed mathematically in a utility function:  |                    |
|    | <ul style="list-style-type: none"> <li>• non-satiation</li> <li>• risk aversion, risk neutrality and risk seeking</li> <li>• declining or increasing absolute and relative risk aversion</li> </ul> |                    |
|    | 1.2.4 Discuss the economic properties of commonly used utility functions.   |                    |
|    | 1.2.5 Discuss how a utility function may depend on current wealth and discuss state-dependent utility functions.  |                    |
|    | 1.2.6 Perform calculations using commonly used utility functions to compare investment opportunities.   |                    |
|    | 1.2.7 State conditions for absolute dominance and for first- and second-order dominance.  |                    |
|    | 1.2.8 Analyse simple insurance problems in terms of utility theory  |                    |

- 1.3 Behavioural economics (Chapter 3)
- 1.3.1 Describe the main features of Kahneman and Tversky's prospect theory critique of expected utility theory.
- 1.3.2 Explain what is meant by 'framing', 'heuristics' and 'bias' in the context of financial markets and describe the following features of behaviour in such markets:
- the herd instinct
  - anchoring and adjustment
  - self-serving bias
  - loss aversion
  - confirmation bias
  - availability bias
  - familiarity bias
- 1.3.3 Describe the Bernartzi and Thaler solution to the equity premium puzzle.
- 2 Measures of investment risk (15%)
- 2.1 Properties of risk measures (Chapter 4)
- 2.1.1 Define the following measures of investment risk:
- variance of return
  - downside semi-variance of return
  - shortfall probabilities
  - Value at Risk (VaR)
  - TailVaR
- 2.1.2 Describe how the risk measures listed in 2.1.1 are related to the form of an investor's utility function.
- 2.1.3 Perform calculations using the risk measures listed in 2.1.1 to compare investment opportunities.
- 2.1.4 Explain how the distribution of returns and the thickness of tails will influence the assessment of risk.
- 2.2 Risk and insurance companies (Chapter 4)
- 2.2.1 Describe how insurance companies help to reduce or remove risk.
- 2.2.2 Explain what is meant by the terms 'moral hazard' and 'adverse selection'.
- 3 Stochastic investment return models (10%)
- 3.1 Show an understanding of simple stochastic models for investment returns. (Chapter 5)

- 3.1.1 Describe the concept of a stochastic investment return model and the fundamental distinction between this and a deterministic model.
  - 3.1.2 Derive algebraically, for the model in which the annual rates of return are independently and identically distributed and for other simple models, expressions for the mean value and the variance of the accumulated amount of a single premium.
  - 3.1.3 Derive algebraically, for the model in which the annual rates of return are independently and identically distributed, recursive relationships that permit the evaluation of the mean value and the variance of the accumulated amount of an annual premium.
  - 3.1.4 Derive analytically, for the model in which each year the random variable  $(1 + r)$  has an independent log-normal distribution, the distribution functions for the accumulated amount of a single premium and for the present value of a sum due at a given specified future time.
  - 3.1.5 Apply the above results to the calculation of the probability that a simple sequence of payments will accumulate to a given amount at a specific future time.
- 4 Asset valuations (20%)
- 4.1 Mean-variance portfolio theory (Chapter 6)
    - 4.1.1 Describe and discuss the assumptions of mean-variance portfolio theory.
    - 4.1.2 Discuss the conditions under which application of mean-variance portfolio theory leads to the selection of an optimum portfolio.
    - 4.1.3 Calculate the expected return and risk of a portfolio of many risky assets, given the expected return, variance and covariance of returns of the individual assets, using mean-variance portfolio theory.
    - 4.1.4 Explain the benefits of diversification using mean-variance portfolio theory.
  - 4.2 Asset pricing models (Chapter 8)
    - 4.2.1 Describe the assumptions, principal results and uses of the Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM).
    - 4.2.2 Discuss the limitations of the basic CAPM and some of the attempts that have been made to develop the theory to overcome these limitations.
    - 4.2.3 Perform calculations using the CAPM.
    - 4.2.4 Discuss the main issues involved in estimating parameters for asset pricing models.
  - 4.3 Single and multifactor models for investment returns (Chapter 7)

- 4.3.1 Describe the three types of multifactor models of asset returns:
- macroeconomic models
  - fundamental factor models
  - statistical factor models
- 4.3.2 Discuss the single-index model of asset returns.
- 4.3.3 Discuss the concepts of diversifiable and non-diversifiable risk.
- 4.3.4 Discuss the construction of the different types of multifactor models.
- 4.3.5 Perform calculations using both single and multifactor models.
- 4.4 Stochastic models for security prices (Chapters 9, 10 and 11)
- 4.4.1 Discuss the continuous time log-normal model of security prices and the empirical evidence for or against the model.
- 4.4.2 Explain the definition and basic properties of standard Brownian motion or Wiener process.
- 4.4.3 Demonstrate a basic understanding of stochastic differential equations, the Ito integral, diffusion and mean-reverting processes.
- 4.4.4 State Ito's Lemma and be able to apply it to simple problems.
- 4.4.5 Produce the stochastic differential equation for geometric Brownian motion and show how to find its solution.
- 4.4.6 Produce the stochastic differential equation for the Ornstein-Uhlenbeck process and show how to find its solution.
- 4.5 Models of the term structures of interest rates (Chapter 18)
- 4.5.1 Explain the principal concepts and terms underlying the theory of a term structure of interest rates.
- 4.5.2 Describe the desirable characteristics of models for the term-structure of interest rates.
- 4.5.3 Apply the term structure of interest rates to modelling various cash flows, including calculating the sensitivity of the value to changes in the term structure.
- 4.5.4 Describe, as a computational tool, the risk-neutral approach to the pricing of zero-coupon bonds and interest-rate derivatives for a general one-factor diffusion model for the risk-free rate of interest.
- 4.5.5 Describe, as a computational tool, the approach using state-price deflators to the pricing of zero-coupon bonds and interest-rate derivatives for a general one-factor diffusion model for the risk-free rate of interest.
- 4.5.6 Demonstrate an awareness of the Vasicek, Cox-Ingersoll-Ross and Hull-White models for the term-structure of interest rates.



- 4.5.7 Discuss the limitations of these one-factor models and show an awareness of how these issues can be addressed.
- 4.6 Simple models for credit risk (Chapter 19)
  - 4.6.1 Define the terms 'credit event' and 'recovery rate'.
  - 4.6.2 Describe the different approaches to modelling credit risk: structural models, reduced form models, intensity-based models.
  - 4.6.3 Demonstrate a knowledge and understanding of the Merton model.
  - 4.6.4 Demonstrate a knowledge and understanding of a two-state model for credit ratings with a constant transition intensity.
  - 4.6.5 Describe how the two-state model can be generalised to the Jarrow-Lando-Turnbull model for credit ratings.
  - 4.6.6 Describe how the two-state model can be generalised to incorporate a stochastic transition intensity.
- 5 Liability valuations (20%)
  - 5.1 Ruin theory (Chapter 20)
    - 5.1.1 Explain what is meant by the aggregate claim process and the cashflow process for a risk.
    - 5.1.2 Use the Poisson process and the distribution of inter-event times to calculate probabilities of the number of events in a given time interval and waiting times.
    - 5.1.3 Define a compound Poisson process and calculate probabilities using simulation.
    - 5.1.4 Define the probability of ruin in infinite/finite and continuous/discrete time, and state and explain relationships between the different probabilities of ruin.
    - 5.1.5 Describe the effect on the probability of ruin, in both finite and infinite time, of changing parameter values by reasoning or simulation.
    - 5.1.6 Calculate probabilities of ruin by simulation.
  - 5.2 Run-off triangles (Chapter 21)
    - 5.2.1 Define a development factor and show how a set of assumed development factors can be used to project the future development of a delay triangle.
    - 5.2.2 Describe and apply a basic chain ladder method for completing the delay triangle using development factors.
    - 5.2.3 Show how the basic chain ladder method can be adjusted to make explicit allowance for inflation.
    - 5.2.4 Describe and apply the average cost per claim method for estimating outstanding claim amounts.

- 5.2.5 Describe and apply the Bornhuetter-Ferguson method for estimating outstanding claim amounts.
- 5.2.6 Describe how a statistical model can be used to underpin a run-off triangles approach.
- 5.2.7 Discuss the assumptions underlying the application of the methods in 5.2.1 to 5.2.6 above.
- 5.3 Value basic benefit guarantees using simulation techniques.
- 6 Option theory (20%)
- 6.1 Option pricing and valuations (Chapters 12 – 17)
- 6.1.1 State what is meant by arbitrage.
- 6.1.2 Outline the factors that affect option prices.
- 6.1.3 Derive specific results for options that are not model dependent:
- Show how to value a forward contract.
  - Develop upper and lower bounds for European and American call and put options.
  - Explain what is meant by put-call parity.
- 6.1.4 Show how to use binomial trees and lattices in valuing options and solve simple examples.
- 6.1.5 Derive the risk-neutral pricing measure for a binomial lattice and describe the risk-neutral pricing approach to the pricing of equity options.
- 6.1.6 Explain the difference between the real-world measure and the risk-neutral measure. Explain why the risk-neutral pricing approach is seen as a computational tool (rather than a realistic representation of price dynamics in the real world).
- 6.1.7 State the alternative names for the risk-neutral and state-price deflator approaches to pricing.
- 6.1.8 Demonstrate an understanding of the Black-Scholes derivative-pricing model:
- explain what is meant by a complete market.
  - explain what is meant by risk-neutral pricing and the equivalent martingale measure.
  - derive the Black-Scholes partial differential equation both in its basic and Garman-Kohlhagen forms.
  - demonstrate how to price and hedge a simple derivative contract using the martingale approach.

- 6.1.9 Show how to use the Black-Scholes model in valuing options and solve simple examples.
- 6.1.10 Discuss the validity of the assumptions underlying the Black-Scholes model.
- 6.1.11 Describe and apply in simple models, including the binomial model and the Black-Scholes model, the approach to pricing using deflators and demonstrate its equivalence to the risk-neutral pricing approach.
- 6.1.12 Demonstrate an awareness of the commonly used terminology for the first, and where appropriate second, partial derivatives (the Greeks) of an option price.

## **Core Reading**

The Subject CM2 Course Notes include the Core Reading in full, integrated throughout the course.

### ***Further reading***

The exam will be based on the relevant Syllabus and Core Reading and the ActEd course material will be the main source of tuition for students.

## 1.3 Subject CM2 – summary of ActEd products

The following products are available for Subject CM2:

- Course Notes
- Paper B Online Resources (PBOR), including the Y Assignments
- X Assignments – four assignments:
  - X1, X2: 80-mark tests (you are allowed 2¾ hours to complete these)
  - X3, X4: 100-mark tests (you are allowed 3¾ hours to complete these)
- Y Assignments – two assignments:
  - Y1, Y2: 100-mark tests (you are allowed 1¾ hours to complete these)
- Series X Marking
- Series Y Marking
- Online Classroom – over 150 tutorial units
- Flashcards
- Revision Notes – ten A5 booklets
- ASET (2014-17 papers) – four years of exam papers, *ie* eight sittings, covering the period April 2014 to September 2017
- ASET (2019-22 papers) – four years of exam papers, covering the period April 2019 to September 2022
- Mock Exam – one 100-mark test for the Paper A examination and a separate 100-mark test for the practical Paper B exam
- Additional Mock Pack (AMP) – two additional 100-mark Paper A tests and two additional 100-mark Paper B tests
- Mock Exam Marking
- Marking Vouchers.

Products are generally available in both paper and eBook format. Visit **ActEd.co.uk** for full details about available eBooks, software requirements and restrictions.

The following tutorials are typically available for Subject CM2:

- Regular Tutorials (four days)
- Block Tutorials (four days)
- a Preparation Day for the practical exam.

Full details are set out in our *Tuition Bulletin*, which is available on our website at **ActEd.co.uk**.

## 1.4 Subject CM2 – skills and assessment

### Technical skills

Subjects CM1 and CM2 are very mathematical and have relatively few questions requiring wordy answers.

### Exam skills

#### *Exam question skill levels*

In the CM subjects, the approximate split of assessment across the three skill types is:

- Knowledge – 20%
- Application – 65%
- Higher Order skills – 15%.

### Assessment

Assessment consists of a combination of a 3¼-hour examination and a 1¼-hour practical data analysis and statistical modelling examination.

## 1.5 Subject CM2 – frequently asked questions

**Q:** *What knowledge of earlier subjects should I have?*

**A:** The Course Notes are written on the assumption that students have studied Subjects CM1, CS1 and CS2. Most students find CM2 quite a tough course and so a good grasp of the material in the earlier subjects is essential. Some of the material in CB2 is also relevant.

**Q:** *What level of mathematics is required?*

**A:** Some of the maths required for this subject is quite advanced – up to degree standard. The techniques covered in Subjects CM1 and CS1 will be treated as assumed knowledge and the theory will build on these. You will find the course much easier if you feel comfortable with the mathematical techniques used in these earlier subjects and you can apply them confidently.

**Q:** *What should I do if I discover an error in the course?*

**A:** If you find an error in the course, please check our website at:

**[ActEd.co.uk/paper\\_corrections.html](http://ActEd.co.uk/paper_corrections.html)**

to see if the correction has already been dealt with. Otherwise please send details via email to **[CM2@bpp.com](mailto:CM2@bpp.com)**.

**Q:** *Who should I send feedback to?*

**A:** We are always happy to receive feedback from students, particularly details concerning any errors, contradictions or unclear statements in the courses.

If you have any comments on this course in general, please email to **[CM2@bpp.com](mailto:CM2@bpp.com)**.

If you have any comments or concerns about the Syllabus or Core Reading, these can be passed on to the Institute and Faculty of Actuaries via ActEd. Alternatively, you can send them directly to the Institute and Faculty of Actuaries' Examination Team by email to **[education.services@actuaries.org.uk](mailto:education.services@actuaries.org.uk)**.

## 2.1 General information and support

### Before you start

When studying for the Institute and Faculty of Actuaries' exams, you will need:

- a copy of the **Formulae and Tables for Examinations of the Faculty of Actuaries and the Institute of Actuaries, 2nd Edition (2002)** – these are referred to simply as the *Tables*
- a **scientific calculator** and/or **software package** to help with calculations.

The *Tables* are available from the Institute and Faculty of Actuaries' eShop. Please visit [actuaries.org.uk](https://www.actuaries.org.uk).

### BPP learning support

BPP's Learning Support team offers a wide range of support for all students who disclose a learning difficulty or disability, including sensory difficulties, mobility difficulty, ADHD, Asperger Syndrome, mental health difficulties, dyslexia, dyspraxia and general health problems. This support is accessible to all ActEd students free of charge.

This support includes:

- accessible and inclusive learning facilities
- a dedicated team that provides information, advice, guidance and support.

Please contact the Learning Support team at [LearningSupport@bpp.com](mailto:LearningSupport@bpp.com) for more information.

### Safeguarding

Safeguarding means protecting people's health, wellbeing and human rights, and enabling them to live free from harm, abuse and neglect.

For ActEd, safeguarding is recognising when someone needs support to help them achieve their learning goals while maintaining their safety, both face-to-face and online.

We want you to feel comfortable within our learning environment and safe in the knowledge that if you ever needed support, you would know where to go.

If you need support, please contact BPP's Safeguarding team at [safeguarding@bpp.com](mailto:safeguarding@bpp.com) or for urgent concerns call 07464 542 636.



## The Prevent Duty

As a Government-regulated training provider, we are responsible for ensuring our learners are well informed and staying safe.

The Prevent Duty is to protect people from radicalisation and being drawn into extremist views and terrorism. ActEd has a duty to ensure that our learners are well informed and stay safe, and to empower our students to know what to look for and when to report concerns.

Please be aware of:

- people sharing or accessing extremist materials
- homophobic, disability-related, religious or racist bullying
- expressions of hatred towards or incitement to harm particular groups
- use of derogatory language towards particular groups.

Please report any concerns to a tutor or email **[safeguarding@bpp.com](mailto:safeguarding@bpp.com)**.

More information is available at:

**[officeforstudents.org.uk/advice-and-guidance/regulation/counter-terrorism-the-prevent-duty](https://officeforstudents.org.uk/advice-and-guidance/regulation/counter-terrorism-the-prevent-duty)**

## 2.2 Core study material

This section explains the role of the Syllabus, Core Reading and supplementary ActEd text. It also gives guidance on how to use these materials most effectively in order to pass the exam.

Some of the information below is also contained in the introduction to the Core Reading produced by the Institute and Faculty of Actuaries.

### Syllabus

The Syllabus for Subject CM2 has been produced by the Institute and Faculty of Actuaries. The relevant individual syllabus objectives are included at the start of each course chapter and a complete copy of the Syllabus is included in Section 1.2 of this Study Guide. We recommend that you use the Syllabus as an important part of your study.

### Core Reading

The Core Reading has been produced by the Institute and Faculty of Actuaries. The purpose of the Core Reading is to assist in ensuring that tutors, students and examiners have clear shared appreciation of the requirements of the Syllabus for the qualification examinations for Fellowship of the Institute and Faculty of Actuaries.

The Core Reading supports coverage of the Syllabus in helping to ensure that both depth and breadth are re-enforced. It is therefore important that students have a good understanding of the concepts covered by the Core Reading.

The examinations require students to demonstrate their understanding of the concepts given in the Syllabus and described in the Core Reading; this will be based on the legislation, Institute and Faculty of Actuarial guidance, *etc* that are in force when the Core Reading is published, *ie* on 31 May in the year preceding the examinations.

Therefore the exams in April and September 2023 will be based on the Syllabus and Core Reading as at 31 May 2022. We recommend that you always use the up-to-date Core Reading to prepare for the exams.

Examiners will have this Core Reading when setting the papers. In preparing for examinations, students are advised to work through past examination questions and will find additional tuition helpful. The Core Reading will be updated each year to reflect changes in the Syllabus, to reflect current practice, and in the interest of clarity.

### Accreditation

The Institute and Faculty of Actuaries would like to thank the numerous people who have helped in the development of the material contained in this Core Reading.

## ActEd text

Core Reading deals with each syllabus objective and covers what is needed to pass the exam. However, the tuition material that has been written by ActEd enhances it by giving examples and further explanation of key points. Here is an excerpt from some ActEd Course Notes to show you how to identify Core Reading and the ActEd material. **Core Reading is shown in this bold font.**

In the example given above, the index *will* fall if the actual share price goes below the theoretical ex-rights share price. Again, this is consistent with what would happen to an underlying portfolio.

After allowing for chain-linking, **the formula for the investment index then becomes:**

$$I(t) = \frac{\sum_i N_{i,t} P_{i,t}}{B(t)}$$

where  $N_{i,t}$  is the number of shares issued for the  $i$ th constituent at time  $t$ ;

**$B(t)$  is the base value, or divisor, at time  $t$ .**

The diagram consists of two rectangular boxes on the right side of the text. The top box contains the text 'This is ActEd text' and has an arrow pointing to the phrase 'the formula for the investment index then becomes:' in the text above. The bottom box contains the text 'This is Core Reading' and has two arrows: one pointing to the bolded phrase 'where  $N_{i,t}$  is the number of shares issued for the  $i$ th constituent at time  $t$ ;' and another pointing to the bolded phrase ' $B(t)$  is the base value, or divisor, at time  $t$ .'

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*Legal action will be taken if these terms are infringed. In addition, we may seek to take disciplinary action through the Institute and Faculty of Actuaries or through your employer.*

These conditions remain in force after you have finished using the course.

## 2.3 ActEd study support

This section gives a description of the products offered by ActEd.

Successful students tend to undertake three main study activities:

1. *Learning* – initial study and understanding of subject material
2. *Revision* – learning subject material and preparing to tackle exam-style questions
3. *Rehearsal* – answering exam-style questions, culminating in answering questions at exam speed.

Different approaches suit different people. For example, you may like to revise material gradually over the months running up to the exams or you may do your revision in a shorter period just before the exams. Also, these three activities will almost certainly overlap.

We offer a flexible range of products to suit you and let you control your own learning and exam preparation. The following table shows the products that we produce. Not all products are available for all subjects.

LEARNING	LEARNING & REVISION	REVISION	REVISION & REHEARSAL	REHEARSAL
Course Notes	Assignments	Flashcards	Revision Notes	Mock Exam
Paper B Online Resources (PBOR)	Combined Materials Pack (CMP)	Sound Revision	ASET	Additional Mock Pack (AMP)
	Assignment Marking			Mock Marking
	Tutorials			
	Online Classroom			

The products and services are described in more detail below.

## **‘Learning’ products**

### ***Course Notes***

The Course Notes will help you develop the basic knowledge and understanding of principles needed to pass the exam. They incorporate the complete Core Reading and include full explanation of all the syllabus objectives, with worked examples and questions (including some past exam questions) to test your understanding.

Each chapter includes:

- the relevant syllabus objectives
- a chapter summary
- a page of important formulae or definitions (where appropriate)
- practice questions with full solutions.

### ***Paper B Online Resources (PBOR)***

The Paper B Online Resources (PBOR) will help you prepare for the practical paper. Delivered through a virtual learning environment (VLE), you will have access to worked examples and practice questions. PBOR will also include the Y Assignments, which are two exam-style assessments.

## **‘Learning & revision’ products**

### ***X Assignments***

The Series X Assignments are assessments that cover the material in each part of the course in turn. They can be used to develop and test your understanding of the material.

The X Assignments come with full marking schedules, and are available with or without marking (see below).

### ***Y Assignments***

The Series Y Assignments are exam-style assessments that cover material across the whole course.

The Y Assignments come with full marking schedules, and are available with or without marking (see below).

### ***Combined Materials Pack (CMP)***

The Combined Materials Pack (CMP) comprises the Course Notes, PBOR and the Series X Assignments.

### ***CMP Upgrade***

The purpose of the CMP Upgrade is to enable you to amend last year’s study material to make it suitable for study for this year.

Wherever possible, it lists the changes to the syllabus objectives, Core Reading, the Course Notes and the X / Y Assignments since last year that might realistically affect your chance of success in the exam. It is produced so that you can manually amend your notes. The upgrade includes replacement pages and additional pages where appropriate.

However, if a large number of changes have been made to the Course Notes and X / Y Assignments, it is not practical to produce a full upgrade, and the upgrade will only *outline* the most significant changes. In this case, we recommend that you purchase a replacement CMP (printed copy or eBook) or Course Notes at a significantly reduced price.

The CMP Upgrade can be downloaded free of charge on our website at **ActEd.co.uk**.

A separate upgrade for eBooks is not produced but a significant discount is available for retakers wishing to re-purchase the latest eBook.

### ***X / Y Assignment Marking***

We are happy to mark your attempts at the X and/or Y assignments. Marking is not included with the Assignments or the CMP and you need to order both Series X and Series Y Marking separately.

**IMPORTANT NOTE: You must submit your script on our virtual learning environment, 'The Hub', in the format detailed in your assignment instructions. You will also be able to download your marked script, including marker feedback, from The Hub, as well as being given the opportunity to provide comments on the quality of the marking.**

Don't underestimate the benefits of attempting and submitting assignments for marking:

- Question practice during this phase of your study gives an early focus on the end goal of answering exam-style questions.
- You're incentivised to keep up with your study plan and get a regular, realistic assessment of your progress.
- Objective, personalised feedback from a high quality marker will highlight areas on which to work and help with exam technique.

In a recent study, we found that students who attempt more than half the assignments and get them marked have significantly higher pass rates.

There are two different types of marking product: Series Marking and Marking Vouchers.

#### *Series Marking*

Series Marking applies to a specified subject, session and student. If you purchase Series Marking, you will **not** be able to defer the marking to a future exam sitting or transfer it to a different subject or student.

We typically provide full solutions with the Series Assignments. However, if you order Series Marking at the same time as you order the Series Assignments, you can choose whether or not to receive a copy of the solutions in advance. If you choose not to receive them with the study material, you will be able to download the solutions from The Hub when your marked script is returned (or following the final deadline date if you do not submit a script).

If you are having your attempts at the assignments marked by ActEd, you should submit your scripts regularly throughout the session, in accordance with the schedule of recommended dates set out on our website at **ActEd.co.uk**. This will help you to pace your study throughout the session and leave an adequate amount of time for revision and question practice.

The recommended submission dates are realistic targets for the majority of students. Your scripts will be returned more quickly if you submit them well before the final deadline dates.

Any script submitted *after* the relevant final deadline date will not be marked. It is your responsibility to ensure that we receive scripts in good time.

### *Marking Vouchers*

Marking Vouchers give the holder the right to submit a script for marking at any time, irrespective of the individual assignment deadlines, study session, subject or person.

Marking Vouchers can be used for any assignment. They are valid for four years from the date of purchase and can be refunded at any time up to the expiry date.

Although you may submit your script with a Marking Voucher at any time, you will need to adhere to the explicit Marking Voucher deadline dates to ensure that your script is returned before the date of the exam. The deadline dates are provided on our website at **ActEd.co.uk**.

### *Tutorials*

Our tutorials are specifically designed to develop the knowledge that you will acquire from the course material into the higher-level understanding that is needed to pass the exam.

We run a range of different tutorials including face-to-face tutorials at various locations, and Live Online tutorials. Full details are set out in our *Tuition Bulletin*, which is available on our website at **ActEd.co.uk**.

### *Regular and Block Tutorials*

In preparation for these tutorials, we expect you to have read the relevant part(s) of the Course Notes before attending the tutorial so that the group can spend time on exam questions and discussion to develop understanding rather than basic bookwork.

You can choose *one* of the following types of tutorial:

- **Regular Tutorials** spread over the session
- a **Block Tutorial** held two to eight weeks before the exam.

The tutorials outlined above will focus on and develop the skills required for the Paper A examination. Students wishing for some additional tutor support working through exam-style questions for Paper B may wish to attend a Preparation Day. These will be available Live Online or face-to-face, where students will need to provide their own device capable of running Excel.

## **Online Classroom**

The Online Classroom acts as either a valuable add-on or a great alternative to a face-to-face or Live Online tutorial, focussing on the Paper A examination.

At the heart of the Online Classroom in each subject is a comprehensive, easily-searched collection of tutorial units. These are a mix of:

- teaching units, helping you to really get to grips with the course material, and
- guided questions, enabling you to learn the most efficient ways to answer questions and avoid common exam pitfalls.

The best way to discover the Online Classroom is to see it in action. You can watch a sample of the Online Classroom tutorial units on our website at **ActEd.co.uk**.

## **'Revision' products**

For most subjects, there is **a lot of material** to revise. Finding a way to fit revision into your routine as painlessly as possible has got to be a good strategy. Flashcards and Sound Revision are inexpensive options that can provide a massive boost. They can also provide a variation in activities during a study day, and so help you to maintain concentration and effectiveness.

### **Flashcards**

Flashcards are a set of A6-sized cards that cover the key points of the subject that most students want to commit to memory. Each flashcard has questions on one side and the answers on the reverse. We recommend that you use the cards actively and test yourself as you go.

### **Sound Revision**

It is reported that only 30% of information that is read is retained but this rises to 50% if the information is also heard. Sound Revision is a set of audio files, designed to help you absorb the most important aspects of the Core Reading.

The files cover the majority of the course, split into a number of manageable topics based on the chapters in the Course Notes. Each section lasts no longer than a few minutes.

### *Choice of revision product*

Different students will have preferences for different revision products.

So, what might influence your choice between these study aids? The following questions and comments might help you to choose the revision products that are most suitable for you:

- Do you have a regular train or bus journey?  
*Flashcards are ideal for regular bursts of revision on the move.*
- Do you want to fit more study into your routine?  
*Flashcards are a good option for 'dead time', eg using flashcards on your phone or sticking them on the wall in your study.*



- Do you find yourself cramming for exams (even if that's not your original plan)?  
*Flashcards are an extremely efficient way to do your pre-exam preparation.*
- Do you have some regular time where carrying other materials isn't practical, eg commuting, at the gym, walking the dog?  
*Sound Revision is an ideal 'hands-free' revision tool.*
- Do you have a preference for auditory learning, eg do you remember conversations more easily than emails?  
*Sound Revision will suit your preferred style and be especially effective for you.*

### *Choosing more than one revision product*

As there is some degree of overlap between revision products, we do not necessarily recommend using them simultaneously. However, if you are retaking a subject, then you might consider using a different product than on a previous attempt to keep your revision fresh and effective.

## **'Revision & rehearsal' products**

### ***Revision Notes***

Our Revision Notes have been designed with input from students to help you revise efficiently. They are suitable for first-time sitters who have worked through the ActEd Course Notes or for retakers (who should find them much more useful and challenging than simply reading through the course again).

The Revision Notes are a set of A5 booklets – perfect for revising in places where taking large amounts of study material with you is not practical. Each booklet covers one main theme or a set of related topics from the course and includes:

- Core Reading to develop your bookwork knowledge
- relevant past exam questions with concise solutions from the last ten years
- other useful revision aids.

### ***ActEd Solutions with Exam Technique (ASET)***

The ActEd Solutions with Exam Technique (ASET) contains our solutions to a number of past exam papers, plus comment and explanation. In particular, it highlights how questions might have been analysed and interpreted so as to produce a good solution with a wide range of relevant points. This will be valuable in approaching questions in subsequent examinations.

### *Choice of revision & rehearsal product*

Different students will have preferences for different revision & rehearsal products, and there is some overlap in that both the Revision Notes and ASET contain past exam paper questions from recent years. However:

- ASET is designed to be educational. It aims to allow you to fully understand the solution points, and to assist you in improving your own answers through focussed explanations and tips on tackling the questions.

It is likely to be most appropriate if you are attempting the questions by producing answers in full, *eg* under exam conditions.

- The past exam question and solution sections of the Revision Notes are designed to give you a greater volume of question practice. They allow you to focus on specific topic areas one at a time.

They are likely to be most appropriate if you are using the questions to develop and practise your idea generation techniques, enabling you to work quickly through more questions than if you were producing full, detailed answers.

## **'Rehearsal' products**

### ***Mock Exam***

The Mock Exam consists of two papers. There is a 100-mark mock exam for the Paper A examination and a separate mock exam for the practical Paper B exam. These provide a realistic test of your exam readiness.

It is based on the Mock Exam from last year but it has been updated to reflect any changes to the Syllabus, Core Reading and examination format.

***The Mock Exam comes with a full marking schedule, and is available with or without marking (see below).***

### ***Additional Mock Pack (AMP)***

The Additional Mock Pack (AMP) consists of four further 100-mark mock exam papers – Mock Exam 2 (Papers A and B) and Mock Exam 3 (Papers A and B). This is ideal if you are retaking and have already sat the Mock Exam, or if you just want some extra question practice.

Mock Exam 2 and Mock Exam 3 come with full marking schedules, and are available with or without marking (see below).

### ***Mock Marking***

We are happy to mark your attempts at the mock exams. The same general principles apply as for the Assignment Marking. In particular:

- Mock Exam Marking applies to a specified subject, session and student. In this subject it covers the marking of both Paper A and Paper B.
- Marking Vouchers can be used for each mock exam paper. You will need two marking vouchers in order to have both Paper A and Paper B marked. Marking vouchers have to be used for marking the AMP exam papers and can be used for marking the Mock Exam.

Recall that:

- marking is not included with the products themselves and you need to order it separately
- you should submit your script via The Hub in the format detailed in the mock exam instructions
- you will be able to download the feedback on your marked script, the solutions if you have Mock Exam Marking, and provide comments on the quality of the marking via The Hub.

## 2.4 Study skills and assessment

### Technical skills

The Core Reading and exam papers for these subjects tend to be very technical. The exams themselves have many calculation and manipulation questions. The emphasis in the exam will therefore be on *understanding* the mathematical techniques and applying them to various, frequently unfamiliar, situations. It is important to have a feel for what the numerical answer should be by having a deep understanding of the material and by doing reasonableness checks.

As a high level of pure mathematics and statistics is generally required for the Core Principles subjects, it is important that your mathematical skills are extremely good. If you are a little rusty you may wish to consider purchasing additional material to help you get up to speed. The course 'Pure Maths and Statistics for Actuarial Studies' is available from ActEd and it covers the mathematical techniques that are required for the Core Principles subjects, some of which are beyond A-Level (or Higher) standard. You do not need to work through the whole course in order – you can just refer to it when you need help on a particular topic. An initial assessment to test your mathematical skills and further details regarding the course can be found on our website at [ActEd.co.uk](https://www.acted.co.uk).

### Study skills

#### *Overall study plan*

We suggest that you develop a realistic study plan, building in time for relaxation and allowing some time for contingencies. Be aware of busy times at work, when you may not be able to take as much study leave as you would like. Once you have set your plan, be determined to stick to it. You don't have to be too prescriptive at this stage about what precisely you do on each study day. The main thing is to be clear that you will cover all the important activities in an appropriate manner and leave plenty of time for revision and question practice.

Aim to manage your study so as to allow plenty of time for the concepts you meet in these courses to 'bed down' in your mind. Most successful students will probably aim to complete the courses at least a month before the exam, thereby leaving a sufficient amount of time for revision. By finishing the courses as quickly as possible, you will have a much clearer view of the big picture. It will also allow you to structure your revision so that you can concentrate on the important and difficult areas.

You can also try looking at our discussion forum, which can be accessed at [ActEd.co.uk/forums](https://www.acted.co.uk/forums) (or use the link from our home page at [ActEd.co.uk](https://www.acted.co.uk)). There are some good suggestions from students on how to study.

#### *Study sessions*

Only do activities that will increase your chance of passing. Try to avoid including activities for the sake of it and don't spend time reviewing material that you already understand. You will only improve your chances of passing the exam by getting on top of the material that you currently find difficult.

Ideally, each study session should have a specific purpose and be based on a specific task, eg *'Finish reading Chapter 3 and attempt Practice Questions 3.4, 3.7 and 3.12'*, as opposed to a specific amount of time, eg *'Three hours studying the material in Chapter 3'*.

Try to study somewhere quiet and free from distractions (eg an area at home dedicated to study). Find out when you operate at your peak, and endeavour to study at those times of the day. This might be between 8am and 10am or could be in the evening. Take short breaks during your study to remain focused – it's definitely time for a short break if you find that your brain is tired and that your concentration has started to drift from the information in front of you.

### **Order of study**

We suggest that you work through each of the chapters in turn. To get the maximum benefit from each chapter you should proceed in the following order:

1. Read the syllabus objectives. These are set out in the box at the start of each chapter.
2. Read the Chapter Summary at the end of each chapter. This will give you a useful overview of the material that you are about to study and help you to appreciate the context of the ideas that you meet.
3. Study the Course Notes in detail, annotating them and possibly making your own notes. Try the self-assessment questions as you come to them. As you study, pay particular attention to the listing of the syllabus objectives and to the Core Reading.
4. Read the Chapter Summary again carefully. If there are any ideas that you can't remember covering in the Course Notes, read the relevant section of the notes again to refresh your memory.
5. Attempt (at least some of) the Practice Questions that appear at the end of the chapter.
6. Where relevant, work through the Paper B Online Resources for the chapter. You will need to have a good understanding of the relevant section of the course before you attempt the corresponding section of PBOR.

It's a fact that people are more likely to remember something if they review it several times. So, do look over the chapters you have studied so far from time to time. It is useful to re-read the Chapter Summaries or to try the Practice Questions again a few days after reading the chapter itself. It's a good idea to annotate the questions with details of when you attempted each one. This makes it easier to ensure that you try all of the questions as part of your revision without repeating any that you got right first time.

Once you've read the relevant part of the notes and tried a selection of questions from the Practice Questions (and attended a tutorial, if appropriate) you should attempt the corresponding assignment. If you submit your assignment for marking, spend some time looking through it carefully when it is returned. It can seem a bit depressing to analyse the errors you made, but you will increase your chances of passing the exam by learning from your mistakes. The markers will try their best to provide practical comments to help you to improve.

To be really prepared for the exam, you should not only know and understand the Core Reading but also be aware of what the examiners will expect. Your revision programme should include plenty of question practice so that you are aware of the typical style, content and marking structure of exam questions. You should attempt as many past exam questions as you can.

### **Active study**

Here are some techniques that may help you to study actively.

1. Don't believe everything you read. Good students tend to question everything that they read. They will ask 'why, how, what for, when?' when confronted with a new concept, and they will apply their own judgement. This contrasts with those who unquestioningly believe what they are told, learn it thoroughly, and reproduce it (unquestioningly?) in response to exam questions.
2. Another useful technique as you read the Course Notes is to think of possible questions that the examiners could ask. This will help you to understand the examiners' point of view and should mean that there are fewer nasty surprises in the exam. Use the Syllabus to help you make up questions.
3. Annotate your notes with your own ideas and questions. This will make you study more actively and will help when you come to review and revise the material. Do not simply copy out the notes without thinking about the issues.
4. Attempt the questions in the notes as you work through the course. Produce your answer before you refer to the solution.
5. Attempt other questions and assignments on a similar basis, *ie* produce your answer before looking at the solution provided. Attempting the assignments under timed conditions has some particular benefits:
  - It forces you to think and act in a way that is similar to how you will behave in the exam.
  - When you have your assignments marked it is *much* more useful if the marker's comments can show you how to improve your performance under timed conditions than your performance when you are under no time pressure.
  - The knowledge that you are going to do an assignment under timed conditions and then submit it (however good or bad) for marking can act as a powerful incentive to make you study each part as well as possible.
  - It is also quicker than trying to produce perfect answers.
6. Sit a mock exam four to six weeks before the real exam to identify your weaknesses and work to improve them. You could use a mock exam written by ActEd or a past exam paper. Ensure that you have your reference materials handy, as you plan to in the actual exam, so that you can practise finding what you need in them quickly and efficiently. (You might even be able to add to / modify your reference materials to increase their usefulness.)

7. Think about what specifically you might want to include from that chapter in the reference materials that you choose to have to hand during the exam. For example, you might want to put together some easy-reference lists of key concepts or formulae that can be referred to quickly and conveniently.

You can find further information on how to study in the Institute and Faculty of Actuaries' Qualification Handbook, which you can download from their website at:

**[actuaries.org.uk/qualify](https://actuaries.org.uk/qualify)**

## **Revision and exam skills**

### ***Revision skills***

You will have sat many exams before and will have mastered the exam and revision techniques that suit you. However it is important to note that due to the high volume of work involved in the Core Principles subjects it is not possible to leave all your revision to the last minute. Students who prepare well in advance have a better chance of passing their exams on the first sitting.

Unprepared students find that they are under time pressure in the exam. Therefore it is important to find ways of maximising your score in the shortest possible time. Part of your preparation should be to practise a large number of exam-style questions under timed conditions as soon as possible. This will:

- help you to develop the necessary understanding of the techniques required
- highlight the key topics, which crop up regularly in many different contexts and questions
- help you to practise the specific skills that you will need to pass the exam.

There are many sources of exam-style questions. You can use past exam papers, the Practice Questions at the end of each chapter (which include many past exam questions), assignments, mock exams, the Revision Notes and ASET.

### ***Exam question skill levels***

Exam questions are not designed to be of similar difficulty. The Institute and Faculty of Actuaries specifies different skill levels at which questions may be set.

Questions may be set at any skill level:

- Knowledge – demonstration of a detailed knowledge and understanding of the topic
- Application – demonstration of an ability to apply the principles underlying the topic within a given context
- Higher Order – demonstration of an ability to perform deeper analysis and assessment of situations, including forming judgements, taking into account different points of view, comparing and contrasting situations, suggesting possible solutions and actions, and making recommendations.

### **Command verbs**

The Institute and Faculty of Actuaries use command verbs (such as 'Define', 'Discuss' and 'Explain') to help students to identify what the question requires. The Institute and Faculty of Actuaries has produced a document, 'Command verbs used in the Associate and Fellowship examinations', to help students to understand what each command verb is asking them to do.

The Institute and Faculty of Actuaries also gives the following advice:

- The use of a specific command verb within a syllabus objective does not indicate that this is the only form of question which can be asked on the topic covered by that objective.
- The examiners may ask a question on any syllabus topic using any of the agreed command verbs, as are defined in the document.

You can find the relevant document on the Institute and Faculty of Actuaries' website at:

**[actuaries.org.uk/qualify/prepare-for-your-exams](https://actuaries.org.uk/qualify/prepare-for-your-exams)**

### **Past exam papers**

You can download past exam papers and Examiners' Reports from the Institute and Faculty of Actuaries' website at **[actuaries.org.uk](https://actuaries.org.uk)**.

### **The examination**

The Institute and Faculty of Actuaries has produced an:

- Examinations Handbook, which includes guidance around notation, suggesting possible standard keyboard notation that students could use when typing solutions in Word during their examinations
- Assessment Regulations document, which includes rules on eligibility, entry and conduct during an online assessment.

The Examinations Handbook and Assessment Regulations document, along with additional information about preparing for, booking and sitting the Institute and Faculty of Actuaries' exams can be found at:

**[actuaries.org.uk/qualify/my-exams/ifoa-exams](https://actuaries.org.uk/qualify/my-exams/ifoa-exams)**

**IMPORTANT NOTE: For the 2023 examinations, these documents will be updated and published in the weeks leading up to each exam session. It is important that you keep up-to-date with any changes and developments.**



For the Paper A exam, ensure you have ready:

- your reference materials, with helpful bookmarks
- rough paper and a pen / pencil
- a calculator / Excel (or equivalent)
- a printer (if you wish to print out the exam paper)
- a copy of the *Tables*.

Please also refer to the Institute and Faculty of Actuaries' website for details about what you will need for the practical Paper B exam.

## 2.5 Queries and feedback

### Questions and queries

From time to time you may come across something in the study material that is unclear to you. The easiest way to solve such problems is often through discussion with friends, colleagues and peers – they will probably have had similar experiences whilst studying. If there's no-one at work to talk to then use our discussion forum at **ActEd.co.uk/forums** (or use the link from our home page at **ActEd.co.uk**).

Our online forum is dedicated to actuarial students so that you can get help from fellow students on any aspect of your studies from technical issues to study advice. You could also use it to get ideas for revision or for further reading around the subject that you are studying. ActEd tutors will visit the site from time to time to ensure that you are not being led astray and we also post other frequently asked questions from students on the forum as they arise.

If you are still stuck, then you can send queries by email to the relevant subject email address (see Section 1.5), but we recommend that you try the forum first. We will endeavour to contact you as soon as possible after receiving your query but you should be aware that it may take some time to reply to queries, particularly when tutors are away from the office running tutorials. At the busiest teaching times of year, it may take us more than a week to get back to you.

If you have many queries on the course material, you should raise them at a tutorial or book a personal tuition session with an ActEd tutor. Information about personal tuition is set out in our current brochure. Please email **ActEd@bpp.com** for more details.

### Feedback

If you find an error in the course, please check the corrections page of our website (**ActEd.co.uk/paper\_corrections.html**) to see if the correction has already been dealt with. Otherwise please send details via email to the relevant subject email address (see Section 1.5).

Each year our tutors work hard to improve the quality of the study material and to ensure that the courses are as clear as possible and free from errors. We are always happy to receive feedback from students, particularly details concerning any errors, contradictions or unclear statements in the courses. If you have any comments on this course, please email them to the relevant subject email address (see Section 1.5).

Our tutors also work with the Institute and Faculty of Actuaries to suggest developments and improvements to the Syllabus and Core Reading. If you have any comments or concerns about the Syllabus or Core Reading, these can be passed on via ActEd. Alternatively, you can send them directly to the Institute and Faculty of Actuaries' Examination Team by email to **education.services@actuaries.org.uk**.