Subject CM2
2025 Study Guide

Contents

1   Introduction

This Study Guide has been created to help you navigate your way through Subject CM2. It contains useful information you will need before starting to study Subject CM2 for the 2025 exams. You may also find it useful to refer to throughout your studies.

Further information on study skills can be found on our website at **ActEd.co.uk**.

Please read this Study Guide carefully before reading the Course Notes, even if you have studied for some actuarial exams before.

Before you start

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

- a copy of the **Formulae and Tables for Examinations of the Institute and Faculty 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**.

2   Subject sequencing and contents

2.1   Links to other subjects

Associateship Qualification

Concepts that underpin the topics in CM2 are introduced in:

- Actuarial Statistics (Subject CS1) – Particularly probabilities, random variables, expectation and variance.

- Risk Modelling and Survival Analysis (Subject CS2) – The understanding of random variables and distribution, time series and stochastic processes.

- Mathematics for Modelling (Subject CM1) – Understanding of the theory of interest rates and modelling techniques.

- Business Economics (Subject CB2) – Familiarity with concepts regarding decision making.

Subjects that are underpinned by CM2 and further develop the topics:

- Actuarial Practice (Subject CP1) – Where CM2 skills are applied to real world problems.

- Modelling Practice (Subject CP2) – Where CM2 modelling techniques applied in a business context.

- Communications Practice (Subject CP3) – May draw upon concepts and techniques from CM1 in order to answer the CP3 examination questions.

Fellowship Qualification

Skills and techniques from CM2 are developed further in the following Specialist Principles subjects, with a focus on solving problems, and giving advice, guidance and recommendations:

- Subject SP5 – Investment and Finance Principles.

- Subject SP6 – Financial Derivatives Principles.

- Subject SP9 – Enterprise Risk Management Principles.

2.2   Subject 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	Measures of investment risk	33			
	4	Portfolio theory	39			
	5	Models of asset returns	30			
	6	Asset pricing models	31			
2	7	Brownian motion and martingales	32	X2		2
	8	Stochastic calculus and Ito processes	47			
	9	Stochastic models of security prices	24			
	10	Characteristics of derivative securities	46			
3	11	The Greeks	18	X3	Y2	3
	12	The binomial model	65			
	13	The Black-Scholes option pricing formula	42			
	14	The 5-step method	59			
4	15	The term structure of interest rates	40	X4		4
	16	Credit risk	31			
	17	Ruin theory	80			
	18	Run-off triangles	72			

3   Syllabus

The Syllabus for each subject is produced by the Institute and Faculty of Actuaries. It includes information to support the study of this subject. The Syllabus will guide you through what you need to learn, the application of learning, as well as the skills that you need to develop.

Students can use the Syllabus as a guide for learning and development. We recommend that you use the Syllabus as an important part of your study.

3.1   Aim

Economic Modelling (Subject CM2) provides a grounding in the principles of actuarial modelling, focusing on stochastic asset models, the valuation of financial derivatives and develops skills to model economic decision making, the probability of ruin, estimation of claims and the pricing of assets and options.

3.2   Topics and topic weightings

This subject covers the following topics:

1.	Rational economic theory	(10%)
2.	Measures of investment risk	(10%)
3.	Asset valuations	(30%)
4.	Liability valuations	(20%)
5.	Option theory	(30%)

The topic weighting percentage noted alongside the topics is indicative of the volume of content of a topic within the subject and therefore broadly aligned to the volume of marks allocated to this topic in the examination. For example, if a topic is 20% of the subject then you can expect that approximately 20% of the total marks available in the examination paper will be available on that topic.

Students should ensure that they are well prepared across the entire syllabus and have an understanding of the principal terms used within the course.

3.3   Objectives

The detailed syllabus objectives for Subject CM2 are given below. To the right of each objective are the chapter numbers in which the objective is covered in the ActEd course. The relevant individual syllabus objectives are also included at the start of each course chapter.

1   Rational economic theory   (10%)

Theories and modelling techniques used to explore, understand and evaluate rational economic decision making and asset pricing. In particular, the application of utility functions to financial and economic problems.

1.1   Understand the principles of rational expectations theory   (Chapter 1)

1.1.1   Three forms of the Efficient Markets Hypothesis and their consequences for investment management

1.1.2   Evidence for or against each form of the Efficient Markets Hypothesis

1.2   Understand the principles of rational choice theory   (Chapter 2)

1.2.1   Meaning of 'utility function'

1.2.2   Concept of utility theory and the expected utility theorem

1.2.3   Understand properties of utility functions that express these economic characteristics of investors:

- Non-satiation
- Risk aversion, risk neutrality and risk seeking
- Declining or increasing absolute and relative risk aversion

1.2.4   Economic properties of commonly used utility functions

1.2.5   Identify how a utility function may depend on current wealth and discuss state-dependent utility functions

1.2.6   Perform calculations using common utility functions that compare investment opportunities

1.2.7   Use utility theory to analyse simple insurance problems

2   Measures of investment risk   (10%)

Apply a range of financial risk measurement tools to evaluate investment opportunities in the context of utility functions. Understand how mitigating actions can reduce risk faced by insurance companies.   (Chapter 3)

2.1   Identify the properties of risk measures and use these risk measures to compare and analyse investment opportunities

2.1.1   Measures of investment risk:

- Variance of return
- Downside semi-variance of return
- Shortfall probabilities
- Value at Risk (VaR)
- TailVaR (also referred to as Expected Shortfall)

2.1.2   How the risk measures listed in are related to the form of an investor's utility function

2.1.3   Compare investment opportunities via calculations using the risk measures listed in 2.1.1

2.1.4   How the distribution of returns and the thickness of tails will influence the assessment of risk

2.2   The role of insurance companies in reducing or removing risk

       2.2.1   How insurance companies help to reduce or remove risk

       2.2.2   The meaning of 'moral hazard' and 'adverse selection'

3   Asset valuations   (30%)

The use of models in portfolio selection and asset pricing, including the term structure of interest rates and credit risk.

3.1   Understand mean-variance portfolio theory and its application   (Chapter 4)

       3.1.1   The assumptions of mean-variance portfolio theory

       3.1.2   When does the application of mean-variance portfolio theory lead to the selection of an optimum portfolio

       3.1.3   Use mean-variance portfolio theory to 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

       3.1.4   Benefits of diversification using mean-variance portfolio theory

3.2   Understand and use the Capital Asset Pricing Model (CAPM)   (Chapter 6)

       3.2.1   The assumptions, principal results and uses of the Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM)

       3.2.2   he limitations of the basic CAPM and some of the attempts that have been made to develop the theory to overcome these limitation

       3.2.3   Perform calculations using the CAPM

       3.2.4   Main issues of estimating parameters for asset pricing models

3.3   Understand and use single and multifactor models for investment returns

                               (Chapter 5)

       3.3.1   Three types of multifactor models of asset returns

- Macroeconomic models
- Fundamental factor models
- Statistical factor models

       3.3.2   Single-index model of asset returns

       3.3.3   Concepts of diversifiable and non-diversifiable risk

       3.3.4   Construction of the different types of multifactor models

       3.3.5   Perform calculations using both single and multifactor models for investment returns

3.4   Appreciate different stochastic models for security prices and how and when they can be applied   (Chapters 7, 8 and 9)

    3.4.1   Continuous time log-normal model of security prices and the empirical evidence for and against the model

    3.4.2   Basic properties of standard Brownian motion or Wiener process

    3.4.3   Principles of stochastic differential equations, the Ito integral, diffusion and mean-reverting processes

    3.4.4   Understand Ito's Lemma and apply it to simple problems

    3.4.5   Describe the stochastic differential equation for geometric Brownian motion

    3.4.6   Describe the stochastic differential equation for the Ornstein-Uhlenbeck process

3.5   Understand the principles and characteristics of models of the term structures of interest rates and their application   (Chapter 15)

    3.5.1   Principal concepts and terms underlying the theory of a term structure of interest rates

    3.5.2   Desirable characteristics of models for the term structure of interest rates

    3.5.3   Apply the term structure of interest rates to modelling various cashflows

    3.5.4   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, as a computational tool

    3.5.5   The Vasicek, Cox-Ingersoll-Ross and Hull-White models for the term structure of interest rates and their limitations

3.6   Understand the principles and application of simple models for credit risk   (Chapter 16)

    3.6.1   What is a 'credit event' and 'recovery rate'

    3.6.2   Identify the different approaches to modelling credit risk: structural models, reduced form models, intensity-based models

    3.6.3   Understand and apply the Merton model

    3.6.4   Understand and apply the two-state model for credit rating with a constant transition intensity

4   Liability Valuations   (20%)

The use of models in insurance to calculate the probability of ruin and estimate claims.

    4.1   Understand the principles and application of ruin theory   (Chapter 17)

        4.1.1   The aggregate claim process and the cashflow process for a risk

        4.1.2   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

        4.1.3   Understand the compound Poisson process and calculate probabilities using simulation

        4.1.4   The probability of ruin in infinite/finite and continuous/discrete time and state, and the relationships between the different probabilities of ruin

        4.1.5   The adjustment coefficient and Lundberg's inequality

        4.1.6   Understand the effect on the probability of ruin, in both finite and infinite time, of changing parameter values by reasoning or simulation

        4.1.7   Maximisation of the adjustment coefficient under proportional reinsurance and excess of loss reinsurance

        4.1.8   Calculate probabilities of ruin by simulation

    4.2   Understand and use run-off triangles to estimate claims   (Chapter 18)

        4.2.1   Understand what a development factor is and show how a set of assumed development factors can be used to project the future development of a delay triangle

        4.2.2   Understand and apply a basic chain ladder method for completing the delay triangle using development factors

        4.2.3   Basic chain ladder method and how this can be adjusted to make explicit allowance for inflation

        4.2.4   Understand and apply the average cost per claim method for estimating outstanding claim amounts

        4.2.5   Understand and apply the Bornhuetter-Ferguson method for estimating outstanding claim amounts

        4.2.6   Understand how a statistical model can be used to underpin a run-off triangles approach

        4.2.7   Understand the assumptions underlying the application of the methods in 4.2.1 to 4.2.6 above

    4.3   Value basic benefit guarantees using simulation techniques

5   **Option theory**   **(30%)**

The construction and evaluation of common forward and option contracts as well as theoretical models for derivatives and option pricing, in particular the theory and application of binomial and Black-Scholes models.

5.1   Understand the principles of option pricing and valuations (Chapters 10 – 14)

5.1.1   What is meant by arbitrage and a complete market

5.1.2   Factors that affect option prices

5.1.3   Determine 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

5.1.4   The meaning of put-call parity

5.2   Understand the principles of the binomial option-pricing model and its application

5.2.1   Use binomial trees and lattices to value options and solve simple examples

5.2.2   Determine the risk-neutral pricing measure for a binomial lattice and describe the risk-neutral pricing approach to the pricing of equity options

5.2.3   Difference between the real-world measure and the risk-neutral measure and why the risk-neutral pricing approach is seen as a computational tool (rather than a realistic representation of price dynamics in the real world)

5.2.4   The alternative names for the risk-neutral and state-price deflator approaches to pricing

5.2.5   Apply the state-price deflator approach to the binomial model and understand its equivalence to the risk-neutral pricing approach

5.3   Understand the principles of the Black-Scholes derivative-pricing model and its application

5.3.1   The martingale representation theorem

5.3.2   Underlying principles of the Black-Scholes partial differential equation both in its basic and Garman-Kohlhagen forms

5.3.3   Use the Black-Scholes model to price and hedge a simple derivative contract using the martingale approach

5.3.4   Value options and solve simple examples using the Black-Scholes model

5.3.5   Apply the state-price deflator approach to the Black-Scholes model and understand its equivalence to the risk-neutral pricing approach

5.3.6   Validity of the assumptions underlying the Black-Scholes model

5.3.7   Commonly used terminology for the first and, where appropriate, second partial derivatives (the Greeks) of an option price

4   Core Reading

This section explains the role of the Core Reading and how it links to the Syllabus, supplementary ActEd text and the examination.

4.1   Core Reading

The Core Reading has been produced by the Institute and Faculty of Actuaries. It supports students in their learning and development of this subject by providing information and explanation of the topics and objectives in the Syllabus.

The Core Reading is updated annually to reflect any changes to the Syllabus and current practice, as well as for continuous improvement.

The current version of the Core Reading is up-to-date as of 31 May 2024. It references the version of any legislation, standards, professional guidance, *etc* as of this date. Any known upcoming changes to the references are noted where relevant in the Core Reading.

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 the Core Reading.

Further reading

A list of additional resources to support candidate learning and development for this subject can be found on the Module pages on the Institute and Faculty of Actuaries' website:

> **actuaries.org.uk/curriculum/**

4.2   Links to the Syllabus

Each part of the Core Reading relates directly to the Syllabus.

The relevant syllabus objectives are included at the start of each chapter for reference.

The Core Reading supports coverage of the Syllabus in helping to ensure that both depth and breadth are re-enforced.

4.3   Links to the examination

Examiners can set questions based on any area of the Syllabus within any examination sitting and will consider and draw from the Core Reading when setting examinations questions.

Students will be expected to apply the Core Reading to scenarios and questions proposed by the examiners.

The exams in April and September 2025 will be based on the Syllabus and Core Reading as at 31 May 2024. We recommend that you always use the up-to-date Core Reading to prepare for the exams.

Past papers indicate to students how the examiners apply the Core Reading. The Examiners' Reports provide further insight as to how students answered the questions and how marks were awarded.

4.4 ActEd text

The Core Reading deals with each syllabus objective and covers what is needed to pass the exam, and the Subject CM2 Course Notes include the Core Reading in full, integrated throughout the course.

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:

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

This is ActEd text

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

This is Core Reading

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

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5   Skills and assessment

5.1   Technical skills

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

5.2   Exam skills

In each examination, students will be expected to demonstrate, through their answers, that they have knowledge of, can apply and use higher order skills in this subject:

*   Knowledge will be demonstrated through answering questions that assess understanding of that knowledge as well as through questions that ask for the application of relevant knowledge to scenarios.

*   Application will be demonstrated through answering questions that assess the ability to identify and apply relevant concepts and skills to solve problems (both numerical and non-numerical).

*   Higher order skills will be demonstrated through questions that will assess the ability to use relevant knowledge, concepts and skills to solve problems, draw appropriate conclusions, and make meaningful and appropriate comments on those conclusions.

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

*   Knowledge – 5%

*   Application – 75%

*   Higher Order skills – 20%.

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 examination can be composed of questions drawing from any part of the syllabus and using any command verb.

The Institute and Faculty of Actuaries has produced guidance on 'Command verbs used in the Associate and Fellowship examinations', to help students to understand what each command verb is asking them to do.

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

actuaries.org.uk/qualify/prepare-for-your-exams

5.3   Assessment

Assessment is in the form of two timed, online examinations:

- Paper A is 3 hours and 20 minutes and consists of a number of questions of varying marks, for which the answers must be constructed and typed in Microsoft Word

- Paper B is 1 hour and 50 minutes and consists of a number of questions of varying marks, for which the answers must be completed, constructed and typed using Microsoft Excel.

This includes reading time, as well as the time taken for students to download and/or print the question paper.

In order to pass this subject, both Paper A and Paper B must be sat within the same sitting, and a combined mark of a pass achieved.

5.4   Further information

The Institute and Faculty of Actuaries has produced a number of documents, which it advises students to read and understand. In particular, the:

- Qualification Handbook, which contains information on studying and preparing for exams, as well as available support and resources

- Examinations Handbook, which contains practical assistance on how to sit an Institute and Faculty of Actuaries' examination

- Assessment Regulations document, which includes rules on eligibility, entry and conduct during an online assessment.

The Qualification Handbook can be found at:

actuaries.org.uk/qualify/student-and-associate-exam-news/qualification-handbook

The Examinations Handbook and Assessment Regulations document can be found at:

actuaries.org.uk/qualify/my-exams/ifoa-exams

IMPORTANT NOTE: These documents may be updated and re-published in the weeks leading up to each exam session. It is important that you keep up-to-date with any changes and developments.

6   ActEd study support

An overview of ActEd's products and services, and guidance on how to choose the best ones for you, can be found on our website at **ActEd.co.uk/productguide**.

6.1   Summary of ActEd products and services

Detailed descriptions of all ActEd's products and services can be found on our website at **ActEd.co.uk**. However, the specific products and services available for Subject CM2 include:

- 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 3¼ 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 – eight A5 booklets

- ASET (2020-23 papers) – four years of exam papers, covering the period April 2020 to September 2023

- Mini-ASET – covering the April 2024 exam paper

- 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.

6.2   Tuition

The following tutorials are typically available for Subject CM2:

- Regular Tutorials (four full days / eight half days)

- Block Tutorials (four days)

- a Preparation Day for the practical exam.

Tutorials are typically available both face-to-face and live online.

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

6.3   Questions and queries

From time to time you may come across something in the study material that is unclear to you.

Our online discussion forum at **ActEd.co.uk/forums** (or use the link from our home page at **ActEd.co.uk**) 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. ActEd tutors visit the site regularly 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 Subject CM2 email address **CM2@bpp.com**, 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 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. Please email **ActEd@bpp.com** for more details.

6.4   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 the details via email to the Subject CM2 email address **CM2@bpp.com**. Our tutors work hard to ensure that the courses are as clear as possible and free from errors.

ActEd also works 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 **memberservices@actuaries.org.uk**.

7 General information and support

7.1 Safeguarding

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

If you need support, please contact BPP's Safeguarding team at **safeguarding@bpp.com** or for urgent concerns call 07464 542 636.

Additional information can be found at **ActEd.co.uk/learningsupport**.

7.2 BPP learning support

BPP's Learning Support team offers a wide range of support for all students who disclose a learning difficulty or disability. This support is accessible to all ActEd students free of charge.

Please contact BPP's Learning Support team at **LearningSupport@bpp.com** for more information.

Additional information can be found at **ActEd.co.uk/learningsupport**.

7.3 The Prevent Duty

The Prevent Duty is to protect people from radicalisation and being drawn into extremist views and terrorism. As a Government-regulated training provider, 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 report any concerns to a tutor or email **safeguarding@bpp.com** or for urgent concerns call 07464 542 636.

More information is available at:

- **ActEd.co.uk/learningsupport**

- **officeforstudents.org.uk/advice-and-guidance/student-wellbeing-and-protection/counter-terrorism-the-prevent-duty/**