2017 Study Guide
Subject CT6

Introduction

This Study Guide contains all the information that you will need before starting to study Subject CT6 for the 2017 exams. Please read this Study Guide carefully before reading the Course Notes, even if you have studied for some actuarial exams before.

When studying for the UK actuarial 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 often referred to as simply the “Yellow Tables”

- a “permitted” scientific calculator – you will find the list of permitted calculators on the profession’s website. Please check the list carefully, since it is reviewed each year.

These are both available from the Institute and Faculty of Actuaries’ eShop. Please visit www.actuaries.org.uk.

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1 The Subject CT6 course structure

There are four parts to the Subject CT6 course. The parts cover related topics and have broadly equal lengths. The parts are broken down into chapters.

The following table shows how the parts, the chapters and the syllabus items relate to each other. The end columns show how the chapters relate to the days of the regular tutorials. This table should help you plan your progress across the study session.

<table>
<thead>
<tr>
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<th>Chapter</th>
<th>Title</th>
<th>No of pages</th>
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2 ActEd study support

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

Different approaches suit different people. For example, you may like to learn 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. Note that not all products are available for all subjects.

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<th>REVISION &amp; REHEARSAL</th>
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The products and services available for Subject CT6 are described 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 short questions to test your understanding.

Each chapter includes the relevant syllabus objectives, a chapter summary and, where appropriate, a page of important formulae or definitions.

“Learning & revision” products

Question and Answer Bank

The Question and Answer Bank provides a comprehensive bank of questions (including some past exam questions) with full solutions and comments.

The Question and Answer Bank is divided into five parts. The first four parts include a range of short and long questions to test your understanding of the corresponding part of the Course Notes. Part five consists of 100 marks of exam-style questions.

X Assignments

The four Series X Assignments (X1 to X4) cover the material in Parts 1 to 4 respectively. Assignments X1 and X2 are 80-mark tests and should take you two and a half hours to complete. Assignments X3 and X4 are 100-mark tests and should take you three hours to complete. The actual Subject CT6 examination will have a total of 100 marks.

Combined Materials Pack (CMP)

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

The CMP is available in eBook format for viewing on a range of electronic devices. eBooks can be ordered separately or as an addition to paper products. Visit www.ActEd.co.uk for full details about the eBooks that are available, compatibility with different devices, software requirements and printing restrictions.
**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 and the ActEd material 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, Question and Answer Bank and X 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 from our website at [www.ActEd.co.uk](http://www.ActEd.co.uk). Alternatively, if the upgrade contains a large number of pages, you may prefer to purchase a hard copy from us at a minimal price to cover production and handling costs.

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

**X Assignment Marking**

We are happy to mark your attempts at the X assignments. Marking is not included with the Assignments or the CMP and you need to order it separately. We recommend that you submit your script by email. Your script will be marked electronically and you will be able to download your marked script via a secure link on the internet.

Don’t underestimate the benefits of doing and submitting assignments:

- 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 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 have significantly higher pass rates.
**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 send out full solutions with the Series X Assignments. However, if you order Series Marking at the same time as you order the Series X 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 via a secure link on the internet 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 in information provided with the assignments. 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 with the assignments.
**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 from our website at [www.ActEd.co.uk](http://www.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** (two or three days) spread over the session.
- **A Block Tutorial** (two or three consecutive days) held two to eight weeks before the exam.

**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.

At the heart of the Online Classroom in each subject is a comprehensive, easily-searched collection of over 100 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 [www.ActEd.co.uk](http://www.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 are an inexpensive option 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.

Flashcards are available in eBook format for viewing on a range of electronic devices. eBooks can be ordered separately or as an addition to paper products. Visit www.ActEd.co.uk for full details about the eBooks that are available, compatibility with different devices, software requirements and printing restrictions.

The following questions and comments might help you to choose whether this revision product is 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 memorising.
“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 eleven A5 booklets – perfect for revising on the train or tube to work. Each booklet covers one main theme or a set of related topics from the course and includes:

- Core Reading with a set of integrated short questions to develop your bookwork knowledge
- relevant past exam questions with concise solutions from the last ten years
- detailed analysis of key past exam questions (selected for their difficulty), and
- other useful revision aids.

ActEd Solutions with Exam Technique (ASET)

The ActEd Solutions with Exam Technique (ASET) contains our solutions to the previous four years’ exam papers, ie eight papers, plus comment and explanation. In particular it will highlight 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.

A “Mini-ASET” will also be available in the summer session covering the April Exam only.

Revision Tutorials

Revision Tutorials are intensive one-day face-to-face or Live Online tutorials in the final run-up to the exam.

They give you the opportunity to practise interpreting and answering past exam questions and to raise any outstanding queries with an ActEd tutor. These courses are most suitable if you have previously attended Regular Tutorials or a Block Tutorial in the same subject.

Details of how to apply for our tutorials are set out in our Tuition Bulletin, which is available from our website at www.ActEd.co.uk.
“Rehearsal” products

Mock Exam A

Mock Exam A is a 100-mark mock exam paper and is a realistic test of your exam preparation. It is based on Mock Exam A from last year but it has been updated to reflect any changes to the Syllabus and Core Reading.

Additional Mock Pack (AMP)

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

Mock / AMP Marking

We are happy to mark your attempts at Mock Exam A or the mock exams included within the AMP. The same general principles apply as for the X Assignment Marking. In particular:

- Mock Exam Marking is available for Mock Exam A and it applies to a specified subject, session and student
- Marking Vouchers can be used for Mock Exam A or the mock exams contained within the AMP; please note that attempts at the AMP can only be marked using Marking Vouchers.

Recall that:

- marking is not included with the products themselves and you need to order it separately
- you should submit your script by email
- your script will be marked electronically and you will be able to download your marked script via a secure link on the internet.

Queries and feedback

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 forum at www.ActEd.co.uk/forums (or use the link from our home page at www.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 CT6@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 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.

If you find an error in the course, please check the corrections page of our website (www.ActEd.co.uk/Html/paper_corrections.htm) to see if the correction has already been dealt with. Otherwise please send details via email to CT6@bpp.com or send a fax to 01235 550085.

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 CT6@bpp.com or fax them to 01235 550085.

Our tutors also work with the profession 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.
3  How to study to pass the exams

The CT Subject exams

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.

Subjects CT2 and CT7 are more “wordy” than the other subjects, including an “essay-style” question or two in Subject CT7.

As a high level of mathematics is required in the courses it is important that your mathematical skills are extremely good. If you are a little rusty you may wish to consider buying the Foundation ActEd Course (FAC). This covers all of the mathematical techniques that are required for the CT Subjects, some of which are beyond A-Level (or Higher) standard. It is a reference document to which you can refer when you need help on a particular topic.

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 CT 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 exam 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 Question and Answer Bank (which includes many past exam questions), assignments, mock exams, the Revision Notes and ASET.
You can find further information on how to study in the profession’s Student Handbook, which you can download from their website at:

www.actuaries.org.uk/studying

**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 this course to “bed down” in your mind. Most successful students will probably aim to complete the course at least a month before the exam, thereby leaving a sufficient amount of time for revision. By finishing the course 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 of the course.

A sample CT subject study plan is available on our website at:

www.ActEd.co.uk/Html/help_and_advice_study_plans.htm

It includes details of useful dates, including assignment deadlines and tutorial finalisation dates.

**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 Questions 1.4, 1.7 and 1.12 from the Question and Answer Bank”, 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 a library or a desk 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 on page 1 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. Our suggested solutions are at the end of each chapter. 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.

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 self-assessment questions again a few days after reading the chapter itself.

You may like to attempt some questions from the Question and Answer Bank when you have completed a part of the course. 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 Question and Answer Bank (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 questions as you can from the Question and Answer Bank and past exam papers.

**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 room! 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. Write down your answer before you refer to the solution.
5. Attempt other questions and assignments on a similar basis, *ie* write down your answer before looking at the solution provided. Attempting the assignments under exam 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 exam conditions than your performance when you have access to the notes and are under no time pressure.
   - The knowledge that you are going to do an assignment under exam 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 write 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.
4 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 Subject CT3. If your knowledge of Subject CT3 is rusty, you might like to revisit some of the CT3 material before you start Subject CT6 (in particular moment generating functions, methods of estimation, and the introduction to compound distributions).

Q: What level of mathematics is required?
A: The level of maths you need for this course is broadly A-level standard. However, there may be some symbols (eg the gamma function) that are not usually included on A-level syllabuses. You will find the course (and the exam!) much easier if you feel comfortable with the mathematical techniques used in the course and you feel confident in applying them yourself. If you feel that you need to brush up on your mathematical skills before starting the course, you may find it useful to study the Foundation ActEd Course (FAC) or read an appropriate textbook. The full Syllabus for FAC, a sample of the Course Notes and an Initial Assessment to test your mathematical skills can be found on our website at www.acted.co.uk.

Q: What calculators am I allowed to use in the exam?
A: Please refer to www.actuaries.org.uk for the latest advice.
5 Core Reading and the Syllabus

Core Reading

The Syllabus for Subject CT6, and the Core Reading that supplements it, 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 6 of this Study Guide. We recommend that you use the Syllabus as an important part of your study. The purpose of the Core Reading is to assist in ensuring that tutors, students and examiners have a clear, shared appreciation of the requirements of the Syllabus. 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.

Core Reading deals with each syllabus objective. Core Reading covers what is needed to pass the exam but the tuition material that has been written by ActEd enhances it by giving examples and further explanation of key points. The Subject CT6 Course Notes include the Core Reading in full, integrated throughout the course. 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.**

Note that 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 becomes:

\[ l(t) = \frac{\sum_{i} N_{i,t}P_{i,t}}{B(t)} \]

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 \( t \).
Core Reading accreditation

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

Changes to the Syllabus and Core Reading

The Syllabus and Core Reading are updated as at 31 May each year. The exams in April and September / October 2017 will be based on the Syllabus and Core Reading as at 31 May 2016.

We recommend that you always use the up-to-date Core Reading to prepare for the exams.

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

Past exam papers

You can download some past exam papers and Examiners’ Reports from the profession’s website at www.actuaries.org.uk.
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.

However, some students may find it useful to obtain a different viewpoint on a particular topic covered in Subject CT6. The following list of further reading for Subject CT6 has been prepared by the Institute and Faculty of Actuaries. This list is not exhaustive and other useful material may be available.


Available from the Publications Unit.
6 Syllabus

The full Syllabus for Subject CT6 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 Statistical Methods subject is to provide a further grounding in mathematical and statistical techniques of particular relevance to financial work.

Links to other subjects

Subject CT3 – Probability and Mathematical Statistics: provides a grounding in probability and statistics.

Subject CA1 – Actuarial Risk Management – develops some of the concepts introduced in this subject.

Subject ST1 – Health and Care Specialist Technical – uses the mathematics developed in this subject.

Subject ST7 – General Insurance – Reserving and Capital Modelling Specialist Technical – uses the mathematics developed in this subject.

Subject ST8 – General Insurance – Pricing Specialist Technical – uses the mathematics developed in this subject.

Subject ST9 – Enterprise Risk Management uses the mathematics developed in this subject.

Objectives

On completion of the subject the trainee actuary will be able to:

(i) Explain the concepts of decision theory and apply them. (Chapter 1)

1. Determine optimum strategies under the theory of games.

2. Explain what is meant by a decision function and a risk function.

3. Apply decision criteria to determine which decision functions are best with respect to a specified criterion. In particular consider the minimax criterion and the Bayes criterion.
(ii) Calculate probabilities and moments of loss distributions both with and without limits and risk-sharing arrangements. (Chapters 3 and 4)

1. Describe the properties of the statistical distributions which are suitable for modeling individual and aggregate losses.

2. Derive moments and moment generating functions (where defined) of loss distributions including the gamma, exponential, Pareto, generalised Pareto, normal, lognormal, Weibull and Burr distributions.

3. Apply the principles of statistical inference to select suitable loss distributions for sets of claims.

4. Explain the concepts of excesses (deductibles), and retention limits.

5. Describe the operation of simple forms of proportional and excess of loss reinsurance.

6. Derive the distribution and corresponding moments of the claim amounts paid by the insurer and the reinsurer in the presence of excesses (deductibles) and reinsurance.

7. Estimate the parameters of a failure time or loss distribution when the data is complete, or when it is incomplete, using maximum likelihood and the method of moments.

(iii) Construct risk models involving frequency and severity distributions and calculate the moment generating function and the moments for the risk models both with and without simple reinsurance arrangements. (Chapters 7 and 8)

1. Construct models appropriate for short term insurance contracts in terms of the numbers of claims and the amounts of individual claims.

2. Describe the major simplifying assumptions underlying the models in 1.

3. Derive the moment generating function of the sum of $N$ independent random variables; in particular when $N$ has a binomial, Poisson, geometric or negative binomial distribution.

4. Define a compound Poisson distribution and show that the sum of independent random variables each having a compound Poisson distribution also has a compound Poisson distribution.

5. Derive the mean, variance and coefficient of skewness for compound binomial, compound Poisson and compound negative binomial random variables.
6. Derive formulae for the moment generating functions and moments of aggregate claims over a given time period for the models in 1. In terms of the corresponding functions for the distributions of claim numbers and claim amounts, stating the mathematical assumptions underlying these formulae.

7. Repeat 5. for both the insurer and the reinsurer after the operation of simple forms of proportional and excess of loss reinsurance.

(iv) Explain the concept of ruin for a risk model. Calculate the adjustment coefficient and state Lundberg’s inequality. Describe the effect on the probability of ruin of changing parameter values and of simple reinsurance arrangements. (Chapter 9)

1. Explain what is meant by the aggregate claim process and the cash-flow process for a risk.

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.

3. Define a compound Poisson process and derive the moments and moment generating function for such a process.

4. Define the adjustment coefficient for a compound Poisson process and for discrete time processes which are not compound Poisson, calculate it in simple cases and derive an approximation.

5. Define the probability of ruin in infinite/finite and continuous/discrete time and state and explain relationships between the different probabilities of ruin.

6. State Lundberg's inequality and explain the significance of the adjustment coefficient.

7. Describe the effect on the probability of ruin, in both finite and infinite time, of changing parameter values.

8. Analyse the effect on the adjustment coefficient and hence on the probability of ruin of simple reinsurance arrangements.
(v) Explain the fundamental concepts of Bayesian statistics and use these concepts to calculate Bayesian estimators. (Chapters 2 and 5)

1. Use Bayes’ Theorem to calculate simple conditional probabilities.
2. Explain what is meant by a prior distribution, a posterior distribution and a conjugate prior distribution.
3. Derive the posterior distribution for a parameter in simple cases.
4. Explain what is meant by a loss function.
5. Use simple loss functions to derive Bayesian estimates of parameters.
6. Explain what is meant by the credibility premium formula and describe the role played by the credibility factor.
7. Explain the Bayesian approach to credibility theory and use it to derive credibility premiums in simple cases.
8. Explain the empirical Bayes approach to credibility theory, in particular its similarities with and its differences from the Bayesian approach.
9. State the assumptions underlying the two models in 8.
10. Calculate credibility premiums for the two models in 8.

(vi) Describe and apply techniques for analysing a delay (or run-off) triangle and projecting the ultimate position. (Chapter 11)

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.
2. Describe and apply the basic chain ladder method for completing the delay triangle.
3. Show how the basic chain ladder method can be adjusted to make explicit allowance for inflation.
4. Discuss alternative ways for deriving development factors which may be appropriate for completing the delay triangle.
5. Describe and apply the average cost per claim method for estimating outstanding claim amounts.
6. Describe and apply the Bornhuetter-Ferguson method for estimating outstanding claim amounts.
7. Describe how a statistical model can be used to underpin a run-off triangles approach.

8. Discuss the assumptions underlying the application of the methods in 1. to 7. above.

(vii) Explain the fundamental concepts of a generalised linear model (GLM), and describe how a GLM may apply.  

1. Be familiar with the principles of Multiple Linear Regression and the Normal Linear Model

2. Define an exponential family of distributions. Show that the following distributions may be written in this form: binomial, Poisson, exponential, gamma, normal.

3. State the mean and variance for an exponential family, and define the variance function and the scale parameter. Derive these quantities for the distributions in 2.

4. Explain what is meant by the link function and the canonical link function, referring to the distributions in 2.

5. Explain what is meant by a variable, a factor taking categorical values and an interaction term. Define the linear predictor, illustrating its form for simple models, including polynomial models and models involving factors.

6. Define the deviance and scaled deviance and state how the parameters of a GLM may be estimated. Describe how a suitable model may be chosen by using an analysis of deviance and by examining the significance of the parameters.

7. Define the Pearson and deviance residuals and describe how they may be used.

8. Apply statistical tests to determine the acceptability of a fitted model: Pearson’s Chi-square test and the Likelihood ratio test

(viii) Define and apply the main concepts underlying the analysis of time series models.

1. Explain the concept and general properties of stationary, I(0), and integrated, I(1), univariate time series.

2. Explain the concept of a stationary random series.

3. Explain the concept of a filter applied to a stationary random series.
4. Know the notation for backwards shift operator, backwards difference operator, and the concept of roots of the characteristic equation of time series.

5. Explain the concepts and basic properties of autoregressive (AR), moving average (MA), autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) time series.

6. Explain the concept and properties of discrete random walks and random walks with normally distributed increments, both with and without drift.

7. Explain the basic concept of a multivariate autoregressive model.

8. Explain the concept of cointegrated time series.

9. Show that certain univariate time series models have the Markov property and describe how to rearrange a univariate time series model as a multivariate Markov model.

10. Outline the processes of identification, estimation and diagnosis of a time series, the criteria for choosing between models and the diagnostic tests that might be applied to the residuals of a time series after estimation.

11. Describe briefly other non-stationary, non-linear time series models.

12. Describe simple applications of a time series model, including random walk, autoregressive and cointegrated models as applied to investment variables.

13. Develop deterministic forecasts from time series data, using simple extrapolation and moving average models, applying smoothing techniques and seasonal adjustment when appropriate.

(ix) Explain the concepts of “Monte Carlo” simulation using a series of pseudo-random numbers. (Chapter 14)

1. Explain the disadvantages of using truly random, as opposed to pseudo-random, numbers.

2. Describe how pseudo-random drawings from specified distributions can be generated.

3. Explain the circumstances in which the same set of random numbers would be used for two sets of simulations and the circumstances in which different sets would be used.

4. Discuss how to decide how many simulations to carry out in order to estimate a quantity of interest.