Subject CS1

2021 Study Guide

Introduction

This Study Guide has been created to help you navigate your way through Subject CS1. It contains all the information you will need before starting to study Subject CS1 for the 2021 exams and you may also find it useful to refer to throughout your Subject CS1 journey.

The guide is split into two parts:

- Part 1 contains specific information about Subject CS1

- 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

1.1   Subject CS1 – background and contents

History

The Actuarial Statistics subjects (Subjects CS1 and CS2) were introduced in the Institute and Faculty of Actuaries 2019 Curriculum.

Subject CS1 is *Actuarial Statistics*.

Predecessors

The topics in the Actuarial Statistics subjects cover content previously in Subjects CT3, CT4, CT6 and a small amount from Subject ST9:

- Subject CS1 contains material from Subjects CT3 and CT6.

- Subject CS2 contains material from Subjects CT4, CT6 and ST9.

Exemptions

In order to be eligible for a pass in Subject CS1, you will need:

- to have passed or been granted an exemption from Subject CT3 during the transfer process

- to have met the profession's requirements based on the current curriculum.

See the profession's website for further details:

www.actuaries.org.uk/studying/exam-exemptions

Prerequisites / required knowledge

The CS1 course assumes that students have a certain level of statistical knowledge before they start. More detail on this is given in the CS1 Syllabus (see pages 4-11 in this document).

If you feel that you do not have this level of background, you may want to consider ordering the ActEd course 'Pure Maths and Statistics for Actuarial Studies'. More information on prerequisites is given later (see page 5 of this document).

Alternatively, a good A-level statistics textbook would help to fill any gaps.

An extra chapter covering the assumed statistical knowledge for Subject CS1 is available on the CS1 page of the ActEd website. A link is given below:

www.ActEd.co.uk/help_and_advice_CS1_assumed_knowledge.html

Links to other subjects

- Subject CS2 – Risk Modelling and Survival Analysis builds directly on the material in this subject.

- Subjects CM1 and CM2 – Actuarial Mathematics and Financial Engineering and Loss Reserving apply the material in this subject to actuarial and financial modelling.

Contents

There are four parts to the Subject CS1 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 days
1	1	Data analysis	23	X1	Y1	1
	2	Probability distributions	63			
	3	Generating functions	30			
	4	Joint distributions	59			
	5	Conditional expectation	20			
2	6	Central Limit Theorem	27	X2		2
	7	Sampling and statistical inference	33			
	8	Point estimation	61			
	9	Confidence intervals	46			
3	10	Hypothesis testing	86	X3		3
	11	Correlation	41			
	12	Linear regression	77			
4	13	Generalised linear models	73	X4	Y2	4
	14	Bayesian statistics	38			
	15	Credibility theory	34			
	16	Empirical Bayes credibility theory	54			

1.2 Subject CS1 – Syllabus and Core Reading

Syllabus

The Syllabus for Subject CS1 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 Actuarial Statistics 1 subject is to provide a grounding in mathematical and statistical techniques that are of particular relevance to actuarial work.

Competences

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

1. describe the essential features of statistical distributions

2. summarise data using appropriate statistical analysis, descriptive statistics and graphical presentation

3. describe and apply the principles of statistical inference

4. describe, apply and interpret the results of the linear regression model and generalised linear models

5. explain the fundamental concepts of Bayesian statistics and use them to compute Bayesian estimators.

Syllabus topics

1. Random variables and distributions   (20%)

2. Data analysis   (15%)

3. Statistical inference   (20%)

4. Regression theory and applications   (30%)

5. Bayesian statistics   (15%)

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.

Assumed knowledge

This subject assumes that a student will be competent in the following elements of foundational mathematics and basic statistics:

1   Summarise the main features of a data set (exploratory data analysis)

  1.1 Summarise a set of data using a table or frequency distribution, and display it graphically using a line plot, a box plot, a bar chart, histogram, stem and leaf plot, or other appropriate elementary device.

  1.2 Describe the level/location of a set of data using the mean, median, mode, as appropriate.

  1.3 Describe the spread/variability of a set of data using the standard deviation, range and interquartile range, as appropriate.

  1.4 Explain what is meant by symmetry and skewness for the distribution of a set of data.

2   Probability

  2.1 Set functions and sample spaces for an experiment and an event.

  2.2 Probability as a set function on a collection of events and its basic properties.

  2.3 Calculate probabilities of events in simple situations.

  2.4 Derive and use the addition rule for the probability of the union of two events.

  2.5 Define and calculate the conditional probability of one event given the occurrence of another event.

  2.6 Derive and use Bayes' Theorem for events.

  2.7 Define independence for two events, and calculate probabilities in situations involving independence.

3   Random variables

  3.1 Explain what is meant by a discrete random variable, define the distribution function and the probability function of such a variable, and use these functions to calculate probabilities.

  3.2 Explain what is meant by a continuous random variable, define the distribution function and the probability density function of such a variable, and use these functions to calculate probabilities.

  3.3 Define the expected value of a function of a random variable, the mean, the variance, the standard deviation, the coefficient of skewness and the moments of a random variable, and calculate such quantities.

3.4   Evaluate probabilities associated with distributions (by calculation or by referring to tables as appropriate).

3.5   Derive the distribution of a function of a random variable from the distribution of the random variable.

Detailed syllabus objectives

1   Random variables and distributions   (20%)

1.1   Define basic univariate distributions and use them to calculate probabilities, quantiles and moments.   (Chapter 2)

1.1.1   Define and explain the key characteristics of the discrete distributions: geometric, binomial, negative binomial, hypergeometric, Poisson and uniform on a finite set.

1.1.2   Define and explain the key characteristics of the continuous distributions: normal, lognormal, exponential, gamma, chi-square, t, F, beta and uniform on an interval.

1.1.3   Evaluate probabilities and quantiles associated with distributions (by calculation or using statistical software as appropriate).

1.1.4   Define and explain the key characteristics of the Poisson process and explain the connection between the Poisson process and the Poisson distribution.

1.1.5   Generate basic discrete and continuous random variables using the inverse transform method.

1.1.6   Generate discrete and continuous random variables using statistical software.

1.2   Independence, joint and conditional distributions, linear combinations of random variables   (Chapter 4)

1.2.1   Explain what is meant by jointly distributed random variables, marginal distributions and conditional distributions.

1.2.2   Define the probability function/density function of a marginal distribution and of a conditional distribution.

1.2.3   Specify the conditions under which random variables are independent.

1.2.4   Define the expected value of a function of two jointly distributed random variables, the covariance and correlation coefficient between two variables, and calculate such quantities.

1.2.5   Define the probability function/density function of the sum of two independent random variables as the convolution of two functions.

1.2.6   Derive the mean and variance of linear combinations of random variables.

1.2.7   Use generating functions to establish the distribution of linear combinations of independent random variables.

1.3   Expectations, conditional expectations   (Chapter 5)

    1.3.1   Define the conditional expectation of one random variable given the value of another random variable, and calculate such a quantity.

    1.3.2   Show how the mean and variance of a random variable can be obtained from expected values of conditional expected values, and apply this.

1.4   Generating functions   (Chapter 3)

    1.4.1   Define and determine the moment generating function of random variables.

    1.4.2   Define and determine the cumulant generating function of random variables.

    1.4.3   Use generating functions to determine the moments and cumulants of random variables, by expansion as a series or by differentiation, as appropriate.

    1.4.4   Identify the applications for which a moment generating function, a cumulant generating function and cumulants are used, and the reasons why they are used.

1.5   Central Limit Theorem – statement and application   (Chapter 6)

    1.5.1   State the Central Limit Theorem for a sequence of independent, identically distributed random variables.

    1.5.2   Generate simulated samples from a given distribution and compare the sampling distribution with the normal.

2   Data analysis   (15%)

2.1   Data analysis   (Chapter 1)

    2.1.1   Describe the possible aims of data analysis (*eg* descriptive, inferential, and predictive).

    2.1.2   Describe the stages of conducting a data analysis to solve real-world problems in a scientific manner and describe tools suitable for each stage.

    2.1.3   Describe sources of data and explain the characteristics of different data sources, including extremely large data sets.

    2.1.4   Explain the meaning and value of reproducible research and describe the elements required to ensure a data analysis is reproducible.

2.2   Exploratory data analysis   (Chapter 11)

    2.2.1   Describe the purpose of exploratory data analysis.

    2.2.2   Use appropriate tools to calculate suitable summary statistics and undertake exploratory data visualizations.

    2.2.3   Define and calculate Pearson's, Spearman's and Kendall's measures of correlation for bivariate data, explain their interpretation and perform statistical inference as appropriate.

      2.2.4   Use principal components analysis to reduce the dimensionality of a complex data set.

2.3   **Random sampling and sampling distributions**   **(Chapter 7)**

      2.3.1   Explain what is meant by a sample, a population and statistical inference.

      2.3.2   Define a random sample from a distribution of a random variable.

      2.3.3   Explain what is meant by a statistic and its sampling distribution.

      2.3.4   Determine the mean and variance of a sample mean and the mean of a sample variance in terms of the population mean, variance and sample size.

      2.3.5   State and use the basic sampling distributions for the sample mean and the sample variance for random samples from a normal distribution.

      2.3.6   State and use the distribution of the t-statistic for random samples from a normal distribution.

      2.3.7   State and use the F distribution for the ratio of two sample variances from independent samples taken from normal distributions.

3   **Statistical inference**   **(20%)**

3.1   **Estimation and estimators**   **(Chapter 8)**

      3.1.1   Describe and apply the method of moments for constructing estimators of population parameters.

      3.1.2   Describe and apply the method of maximum likelihood for constructing estimators of population parameters.

      3.1.3   Define the following terms: efficiency, bias, consistency and mean square error.

      3.1.4   Define and apply the property of unbiasedness of an estimator.

      3.1.5   Define the mean square error of an estimator, and use it to compare estimators.

      3.1.6   Describe and apply the asymptotic distribution of maximum likelihood estimators.

      3.1.7   Use the bootstrap method to estimate properties of an estimator.

3.2   **Confidence intervals**   **(Chapter 9)**

      3.2.1   Define in general terms a confidence interval for an unknown parameter of a distribution based on a random sample.

      3.2.2   Derive a confidence interval for an unknown parameter using a given sampling distribution.

      3.2.3   Calculate confidence intervals for the mean and the variance of a normal distribution.

3.2.4   Calculate confidence intervals for a binomial probability and a Poisson mean, including the use of the normal approximation in both cases.

3.2.5   Calculate confidence intervals for two-sample situations involving the normal distribution, and the binomial and Poisson distributions using the normal approximation.

3.2.6   Calculate confidence intervals for a difference between two means from paired data.

3.2.7   Use the bootstrap method to obtain confidence intervals.

3.3   Hypothesis testing and goodness of fit   (Chapter 10)

3.3.1   Explain what is meant by the following terms: null and alternative hypotheses, simple and composite hypotheses, type I and type II errors, test statistic, likelihood ratio, critical region, level of significance, probability value and power of a test.

3.3.2   Apply basic tests for the one-sample and two-sample situations involving the normal, binomial and Poisson distributions, and apply basic tests for paired data.

3.3.3   Apply the permutation approach to non-parametric hypothesis tests.

3.3.4   Use a chi-square test to test the hypothesis that a random sample is from a particular distribution, including cases where parameters are unknown.

3.3.5   Explain what is meant by a contingency (or two-way) table, and use a chi-square test to test the independence of two classification criteria.

4   Regression theory and applications   (30%)

4.1   Linear regression   (Chapter 12)

4.1.1   Explain what is meant by response and explanatory variables.

4.1.2   State the simple regression model (with a single explanatory variable).

4.1.3   Derive the least squares estimates of the slope and intercept parameters in a simple linear regression model.

4.1.4   Use appropriate software to fit a simple linear regression model to a data set and interpret the output.

•   Perform statistical inference on the slope parameter.

•   Describe the use of measures of goodness of fit of a linear regression model.

•   Use a fitted linear relationship to predict a mean response or an individual response with confidence limits.

•   Use residuals to check the suitability and validity of a linear regression model.

4.1.5   State the multiple linear regression model (with several explanatory variables).

4.1.6   Use appropriate software to fit a multiple linear regression model to a data set and interpret the output.

4.1.7   Use measures of model fit to select an appropriate set of explanatory variables.

4.2   Generalised linear models   (Chapter 13)

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

4.2.2   State the mean and variance for an exponential family, and define the variance function and the scale parameter. Derive these quantities for the distributions above.

4.2.3   Explain what is meant by the link function and the canonical link function, referring to the distributions above.

4.2.4   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.

4.2.5   Define the deviance and scaled deviance and state how the parameters of a generalised linear model 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.

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

4.2.7   Apply statistical tests to determine the acceptability of a fitted model: Pearson's chi-square test and the likelihood ratio test.

4.2.8   Fit a generalised linear model to a data set and interpret the output.

5   Bayesian statistics   (15%)

(Chapters 14, 15 and 16)

5.1   Explain the fundamental concepts of Bayesian statistics and use these concepts to calculate Bayesian estimators.

5.1.1   Use Bayes' theorem to calculate simple conditional probabilities.

5.1.2   Explain what is meant by a prior distribution, a posterior distribution and a conjugate prior distribution.

5.1.3   Derive the posterior distribution for a parameter in simple cases.

5.1.4   Explain what is meant by a loss function.

5.1.5   Use simple loss functions to derive Bayesian estimates of parameters.

5.1.6   Explain what is meant by the credibility premium formula and describe the role
         played by the credibility factor.

5.1.7   Explain the Bayesian approach to credibility theory and use it to derive credibility
         premiums in simple cases.

5.1.8   Explain the empirical Bayes approach to credibility theory and use it to derive
         credibility premiums in simple cases.

5.1.9   Explain the differences between the two approaches and state the assumptions
         underlying each of them.

Core Reading

The Subject CS1 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 CS1 – summary of ActEd products

The following products are available for Subject CS1:

- Course Notes

- Paper B Online Resource (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

- ASET (2014-17 papers) – four years of exam papers, *ie* eight sittings, covering the period April 2014 to September 2017

- ASET (2019-20 papers) – two years of exam papers, covering the period April 2019 to September 2020

- Mock Exam – one 100-mark test for the written Paper A examination and a separate 100-mark test for the computer-based 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 **www.ActEd.co.uk** for full details about available eBooks, software requirements and restrictions.

The following tutorials are typically available for Subject CS1:

- Regular Tutorials (four days)

- Block Tutorials (four days)

- a Preparation Day for the computer-based exam.

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

1.4   Subject CS1 – skills and assessment

Technical skills

Subjects CS1 and CS2 are very mathematical and have relatively few questions requiring wordy answers.

Exam skills

Exam question skill levels

In the CS 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 written examination and a 1¾-hour computer-based data analysis and statistical modelling examination.

1.5   Subject CS1 – frequently asked questions

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

A: No knowledge of earlier subjects is required.

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 (*eg* integration by parts) used in the course and you feel confident in applying them yourself.

If your maths or statistics is 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.

You may also find this Assumed Knowledge chapter useful:

www.ActEd.co.uk/help_and_advice_CS1_assumed_knowledge.html

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:

www.ActEd.co.uk/paper_corrections.html

to see if the correction has already been dealt with. Otherwise please send details via email to **CS1@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 **CS1@bpp.com**.

If you have any comments or concerns about the Syllabus or Core Reading, these can be passed on to the profession 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**.

2.1   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*

- an 'authorised' **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**.

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 CS1 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, professional 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 2021 will be based on the Syllabus and Core Reading as at 31 May 2020. 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*.**

This is ActEd text

This is Core Reading

Here is an excerpt from some ActEd Course Notes to show you how to identify Core Reading for R code.

R

The R code to draw a scatterplot for a bivariate data frame, `<data>`**, is:**

```
plot(<data>)
```

Further explanation on the use of R will not be provided in the Course Notes, but instead be picked up in the Paper B Online Resources (PBOR). We recommend that you refer to and use PBOR at the end of each chapter, or couple of chapters, that contains a significant number of R references.

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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 without notes.

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 Combined Materials Pack (CMP) Assignment Marking Tutorials Online Classroom	Flashcards	Revision Notes ASET	Mock Exam Additional Mock Pack (AMP) Mock Marking

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 computer-based 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 written 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.

Y Assignments

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

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 **www.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. You should submit your script as an attachment to an email, in the format detailed in your assignment instructions. You will be able to download your marker's feedback via a secure link.

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 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 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 via a secure link 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 **www.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 **www.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 **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** 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 written 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 R.

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 written 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 **www.ActEd.co.uk**.

'Revision' products

Flashcards

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 a relatively 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 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.

The following questions and comments might help you to decide if flashcards are 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.

If you are retaking a subject, then you might consider using flashcards if you didn't use them on a previous attempt.

'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 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 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.

'Rehearsal' products

Mock Exam

The Mock Exam consists of two papers. There is a 100-mark mock exam for the written Paper A examination and a separate mock exam for the computer-based 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 and Core Reading.

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 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 mocks 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 email in the format detailed in the mock exam instructions

- you will be able to download the feedback on your marked script via a secure link.

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 **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 **www.ActEd.co.uk/forums** (or use the link from our home page at **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* 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 8*am* and 10*am* 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 relevant Paper B Online Resources for the chapter(s). You will need to have a good understanding of the relevant section of the paper-based 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 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.

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

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 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 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 profession 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.

It 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 profession's website at:

www.actuaries.org.uk/studying/prepare-your-exams

Past exam papers

You can download some past exam papers and Examiners' Reports from the profession's website at **www.actuaries.org.uk**. However, please be aware that the majority of these exam papers are for the pre-2019 syllabus and so not all questions will be relevant.

The examination

IMPORTANT NOTE: The following information was correct at the time of printing, however it is important to keep up-to-date with any changes. See the profession's website for the latest guidance.

For the written exams the examination room will be equipped with:

- the question paper

- an answer booklet

- rough paper

- a copy of the *Tables*.

Remember to take with you:

- black pens

- an authorised scientific calculator – please refer to **www.actuaries.org.uk** for the latest advice.

Please also refer to the profession's website and your examination instructions for details about what you will need for the computer-based 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 **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 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 (**www.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 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**.