| ACTUARIAL REFERENCE No (ARN) | | | | | | |
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# INSTITUTE AND FACULTY OF ACTUARIES

# EXAMINATION BOOKLET

## September 2015

## CA2: Model Documentation, Analysis and Reporting

## Paper 1

**DO NOT OPEN UNTIL INSTRUCTED TO DO SO.**

**Examination instructions**

**1.** You should periodically save all the files you are working on onto the PC's hard drive.

You will be given instructions for submitting your work at the end of the examination.

**It is your responsibility to ensure your work is adequately saved.**

**2.** At the end of the allotted time, or when you have completed your exam, you need to submit your work.

Your filenames must include your ARN (**e.g. Audit_ARN.docx)**. Ensure that your spreadsheet model and audit trail are clearly labelled and also contain your ARN as a header or footer on at least one page.

**Please note that you should use your ARN and NOT your name on all of the material you submit for marking.**

**The work you submit MUST be saved in Microsoft 2007 format, i.e. using docx (Word) or xlsx (Excel) file extensions. Do not embed documents in your spreadsheet.**

**3.** You must submit your spreadsheet model and audit trail by the end of the stated exam time. By submitting your files you are confirming that all material is entirely your own work and you wish this to be taken into account for this assessment.

**It is your responsibility to ensure that a complete electronic copy of your work is submitted.**

You must stop working after this time as failure to do so could result in your exam not being marked.

**4.** You must also hand in this examination booklet, together with any other materials from the examination. This includes handing in any planning or rough notes that you have made during the examination, and any print-outs that you have done of your work.

**Professional behaviour is mandatory and no material relating to the exam may be taken from the exam room nor disclosed or discussed with others.**

**Failure to comply with this will be deemed to be a breach of examination regulations and may result in disciplinary action.**

**This booklet contains an insert with additional guidance.**

**Data has been provided electronically.**

**You should use the first 15 minutes of the exam as reading and planning time.**

 

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# Exam requirements

**1.** Read the background document, which describes the scenarios that need to be modelled and documented for this project. Technical assistance for the modelling work, should you require it, can be found in the additional guidance contained in this booklet.

*No marks will be deducted for the use of this guidance.*

**2.** Construct a spreadsheet model that produces the following calculations and charts. You should ensure that your spreadsheet contains appropriate self-checks and that you have performed robust reasonableness checks at each stage of your calculations.

(i) Check the data provided, including validating that it can be treated as having been generated from a continuous Uniform distribution on [0,1]. [It is not necessary to make any changes to the data.] [7]

(ii) Simulate a series of pass and fail indicators for each of the 200 new students over 10 years under the base scenario, using half year projection periods. [3]

(iii) Determine the number of students simulated to have passed $X$ exams at the end of the 10 year period, for $X = 0$ to 10, under the base scenario. [2]

(iv) Illustrate the results from part (iii) using a suitable chart. [2]

(v) Determine the simulated proportion of students who have qualified by the end of the 10 year period, under the base scenario. [1]

(vi) Use cumulative persistency rates to adjust the simulated pass and fail indicators in order to allow for withdrawals. [5]

(vii) Repeat part (iii) using these adjusted indicators, i.e. allowing for withdrawals. [2]

(viii) Illustrate the results from part (vii) using a suitable chart. [2]

(ix) Repeat part (v) under the withdrawal scenario. [1]

(x) Repeat parts (ii) and (iii) using the higher pass rate. [3]

(xi) Illustrate the results from part (x) using a suitable chart. [2]

(xii) Repeat part (v) using the higher pass rate. [1]

**Marks available for spreadsheet model and checks:**

**Accurate completion of above modelling steps and data checks [31]**
**Demonstration of good modelling technique and practice [7]**
**Other (non-data) checks [7]**

**[Sub-total 45]**

**3.** Produce an audit trail for your spreadsheet model which includes the following:

- purpose of the model
- data and assumptions used
- methodology, i.e. description of how each calculation stage in the model has been produced
- explanation of any checks performed

You should ensure that your audit trail is suitable for both a senior actuary, who has been asked to approve your work, and a fellow student, who has been asked to peer review and correct your model, or to continue work on it, or to use it again for a similar purpose in the future.

**Marks available for audit trail:**

**Audit approach**

- **Fellow student can review and check methods used in the model [8]**
- **Senior actuary can scrutinise and understand what has been done [8]**
- **Written in clear English [4]**
- **Written in a logical order [3]**

**Audit content**

- **All steps clearly explained [7]**
- **Clear signposting included throughout [5]**
- **Statement of assumptions made [5]**
- **All model steps accurately covered [15]**

**[Sub-total 55]**

**[Total 100]**

# Background

You are an actuarial student working for a consultancy in the country of Actuaria.

The Actuarian Institute of Surgeons (AIS) has recently changed its examination system. It has approached your boss, a qualified actuary, and has asked her to provide assistance in modelling the expected progress of an intake of new students through the revised exams.

In order to qualify as a surgeon, a student has to pass 10 exams. These are held twice a year in June and December, and students are only allowed to sit one exam at a time. However, there is no limit on the number of times that they can retake each exam.

The AIS has stated that it is anticipating a pass rate of 0.4 for each exam (i.e. it is anticipating that 40% of the students sitting that exam will pass it).

It expects 200 new students to join the profession at the start of the next calendar year (i.e. on 1 January) and is interested in understanding what the progress of these 200 students might be through the exams over a 10 year period.

**Base scenario**

Your boss has therefore asked you to produce a simulation model to illustrate the possible outcomes for 200 new students of the AIS over a 10 year period.

For this base scenario, she has asked you to ignore the possibility of students deciding to leave the profession and to assume that they each continue to sit exams throughout the 10 year period (or until they qualify, if earlier).

For each student, you need to simulate either a pass or fail in each of the 20 half year time periods. She has recommended that you do this by simulating a 1 for a pass and a 0 for a fail.

In order to perform this simulation, she has provided you with 4,000 randomly generated numbers from a continuous Uniform distribution on [0,1]. These are provided electronically in a data file, presented in 20 columns and 200 rows.

Your boss has reminded you that you will need to allow for the fact that there are only 10 exams in total.

Having performed these base scenario simulations, you have been asked to determine the following summary statistics as at the end of the 10 year period:

- The simulated number of students (out of 200) who have passed $X$ exams, for $X = 0$ to 10.
- The simulated proportion of the 200 students who have qualified as surgeons.

**Withdrawal scenario**

Your boss is aware that the students may withdraw from membership of the profession at any time, so she has asked the AIS for information on the expected withdrawal rates.

It has provided the following information:

- Expected withdrawal rate in half year period following an exam pass at the end of the previous half year period = 0.005.

- Expected withdrawal rate in half year period following an exam failure at the end of the previous half year period = 0.05.

You have been asked to extend the model to simulate also the expected numbers of passes for the same group of 200 new students, allowing for expected withdrawal rates over the projection period.

You should do this by first calculating the cumulative persistency rate for each half year time period and for each student.

The expected number of passes in each time period allowing for withdrawals can then be determined for each student as the 0 (fail) or 1 (pass) indicator multiplied by the appropriate cumulative persistency rate.

Your boss has asked you to use these revised calculations to determine the same summary statistics as for the base scenario.

**Higher pass rate scenario**

The AIS has also suggested that, if the simulated results are not satisfactory, it may adjust the standard of the exams so that the pass rate is anticipated to be 0.5 rather than 0.4.

Your boss has therefore asked you to produce a further set of simulations and summary statistics using this higher pass rate. In doing so, you should **ignore** withdrawals (i.e. this is a variation on the base scenario, which does not allow for withdrawals).

# END OF PAPER