

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

14 September 2021 (am)

Subject CM1 – Actuarial Mathematics

Core Principles

Paper B

Time allowed: One hour and fifty minutes

<p>In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator.</p>
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If you encounter any issues during the examination please contact the Assessment Team on
T. 0044 (0) 1865 268 873.

- 1** A 1-year term assurance contract provides a death benefit of £100,000 payable at the end of the month of death to a life currently aged 70 exact.
- (i) (a) Calculate the expected present value of the contract assuming a constant force of mortality.
- (b) Calculate the expected present value of the contract using the Uniform Distribution of Deaths (UDD) method. [15]
- (ii) Comment on the differences between your answers to parts (i)(a) and (i)(b).
- Basis:
- | | |
|-------------------|---------------------|
| Rate of mortality | $q_{70} = 0.012437$ |
| Interest | 1% per month |
| Expenses | Nil |
- [5]
[Total 20]

- 2** A couple are buying a house and have taken out a special ‘First-time buyer’ mortgage, which allows for lower payments in the earlier years.

The mortgage, of £300,000, has a term of 30 years. For the first 6 months, no repayments are made, although interest still accrues on the loan. Interest-only repayments are due from this point until the end of the third year. After the end of the third year, and up to the end of the term, level repayments are due, set at a level such that the mortgage will be repaid in full at the end of the 30-year term.

All repayments are made monthly in arrears. Interest is charged at an effective rate of 4.5% p.a.

- (i) Calculate the amount of each monthly repayment, **without** using a scenario solving tool such as Goal Seek or Solver. [7]
- (ii) Construct the loan schedule for the mortgage. [8]

The conditions of the loan permit borrowers to make additional payments in order to reduce the term of the mortgage. These additional payments can be made once each year, excluding the first year, subject to a maximum of 10% of the outstanding capital amount, as determined at the beginning of each year of payment. The original repayments, including the repayments in the first 3 years, will not change but the term of the mortgage will reduce.

The original repayment schedule will remain unchanged except for the term.

The couple decide to make additional payments to reduce the term of the mortgage as much as possible.

- (iii) Determine the shortest possible term that can be achieved in this way. [11]
[Total 26]

- 3** An actuarial team has been tasked with building a model to evaluate the impact of a change in interest rates on the value of a bond. A student in the team has constructed two models: Model 1 and Model 2. The results of the models are provided in the Excel workbook in the Q3 Model 1 and Q3 Model 2 worksheets.

Explain the limitations of each of the two models on the basis of the calculations and results shown in these worksheets. You are not expected to validate the accuracy of the models, and you are not required to perform further calculations. [12]

- 4** A life insurance company issues a 30-year unit-linked joint life endowment assurance policy to a man aged 32 exact and a woman aged 35 exact.

Should either life die during the term a benefit of \$200,000, or the bid value of the units if higher, is payable at the end of the year of the first death. On survival of both lives to maturity, 102% of the bid value of the units is payable. On early surrender, the bid value of the units less a surrender penalty is payable at the end of the policy year of surrender.

Premiums, which increase at a fixed rate each year, are payable annually in advance throughout the policy or until the death of the first life.

The premium structure, as well as the mortality, surrender and pricing assumptions, are set out in the Q4 Base worksheet.

- (i) Determine the unit fund cashflows for each year of the policy. [9]

Independent decrement rates have been provided in the Q4(ii) worksheet.

- (ii) Calculate the profit margin for this policy. [33]
[Total 42]

END OF PAPER