

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

23 September 2019 (am)

Subject CM1B – Actuarial Mathematics Core Principles

Time allowed: One hour and forty-five minutes

INSTRUCTIONS TO THE CANDIDATE

1. *You are given this question paper and the Excel file.*
2. *Mark allocations are shown in brackets.*
3. *Attempt all questions. Each question is to be answered in the allocated tab.*

If you encounter any issues during the examination, please contact the Examinations Team at
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- 1 A company offers a life assurance policy that pays a lump sum of £100,000 on the death of an employee before age 60. The benefit is payable at the end of the year of death. In addition, an annuity of £5,000 per annum is paid to a nominated dependant of the life assured. The first annuity payment is made at the same time as the lump sum death benefit and continues annually, ceasing when the dependant reaches age 60 exact or on their earlier death.

It estimates the mortality experience of its employees by using mortality tables given in the answer sheet under the 'Q1 Base' tab.

- (i) Calculate, for a male life aged 35 exact as the life assured and with a female life aged 30 exact as the dependant, using the mortality tables provided and an interest rate of 5% per annum:
- (a) the expected present value of the lump sum benefit.
 - (b) the expected present value of the dependant's annuity benefit.

[14]

The company has now decided to allow for employees who leave the company. Those who leave are deemed to have withdrawn from the life insurance policy and as such, their policy is cancelled and no further benefits are payable. The company has created a multiple decrement table based on mortality and withdrawal rates experienced in its own portfolio over the last twenty years. The table for male lives is given in the answer sheet under the 'Q1 (ii)' tab.

- (ii) Calculate the independent forces of mortality and withdrawal implied by this multiple decrement table. You may assume these independent forces are constant over each year of age and that the different forces are independent of one another.

[10]

The company wishes to adjust the multiple decrement table used in part (ii) to allow for the tables used in part (i).

- (iii)
- (a) Calculate the independent forces of mortality for a male life between ages 35 and 60 inclusive as implied by the tables used in part (i).
 - (b) Calculate the adjusted dependent rates of mortality and withdrawal for a male life over this age range based on the revised mortality rates in part (iii)(a) and the withdrawal rates in part (ii).
 - (c) Determine the revised expected present value for the lump sum benefit originally calculated in part (i)(a), assuming that the benefit is paid only if the life dies while an employee of the company.

[22]

- (iv) Comment on the differences in your results for part (i)(a) and part (iii)(c). [6]
[Total 52]

- 2** An investor has a choice between two projects (Project A and Project B) and believes that a risk discount rate of 10% per annum effective is appropriate to evaluate these projects.

Project A

The outgo for Project A is as follows:

- £500,000 on 1 January 2018
- £300,000 on 1 April 2018.

Income is received continuously from 1 July 2018. The income starts at £500,000 per annum for the first year and decreases by £20,000 every year on 1 July.

- (i) (a) Construct a half-yearly cashflow schedule for Project A.
(b) Calculate the accumulated profit for Project A at 31 December 2037. [15]

Project B

The outgo for Project B is all paid on 1 January 2018.

The project immediately starts earning income. The income will be received continuously at an initial rate of £70,000 per annum. The income will increase at a compound rate of 20% per annum every two years with the first increase taking place on 1 January 2020.

- (ii) (a) Construct a yearly cashflow schedule for Project B.
(b) Calculate the initial outgo for Project B such that it will have the same accumulated profit as Project A at 31 December 2037. [12]

The investor does not have enough capital to cover the outgo for Project B and so decides to borrow £750,000 from a bank. The loan will be repaid over 20 years. Level repayments will be made annually in arrears and the bank will charge interest at a rate of 12% per annum effective for the first 10 years and 14% per annum effective for the next 10 years.

- (iii) Calculate the annual loan repayments. [5]

The company decides that it would like to repay the loan as early as possible and so pays all of the income from Project B into the loan account as it is received. In years when the income is not sufficient to cover the regular loan repayments, any shortfall is added to the outstanding loan amount.

- (iv) Construct a loan schedule and calculate the calendar year in which the loan is fully repaid. [16]
[Total 48]

END OF PAPER