

INSTITUTE AND FACULTY OF ACTUARIES



EXAMINATION

17 September 2018 (pm)

Subject CT5 – Contingencies Core Technical

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*
2. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*
3. *You have 15 minutes of planning and reading time before the start of this examination. You may make separate notes or write on the exam paper but not in your answer booklet. Calculators are not to be used during the reading time. You will then have three hours to complete the paper.*
4. *Mark allocations are shown in brackets.*
5. *Attempt all 13 questions, beginning your answer to each question on a new page.*
6. *Candidates should show calculations where this is appropriate.*

Graph paper is NOT required for this paper.

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.

1 Calculate:

(a) ${}_{12}q_{[54]}$

(b) $\ddot{a}_{65}^{(6)}$

(c) $\overline{s}_{43:10|}$

Basis:

Mortality	AM92
Rate of Interest	4% per annum

[4]

2 A reversionary continuous annuity begins on the death of life x , if a second life y is then alive. Payment continues during the lifetime of y .

(a) State, using random variables, the present value of this annuity.

(b) Give an expression for the expected present value of this annuity in terms of assurance functions.

[4]

3 A life insurance company sells a special immediate annuity policy to a life aged 65 exact. The policy provides an annuity of 30,000 a year payable monthly in advance. Payment is guaranteed for the first five years and thereafter ceases immediately on the death of the policyholder.

Calculate the expected present value of this annuity.

Basis:

Mortality	PFA92C20
Rate of Interest	4% per annum
Expenses	Ignore

[4]

4 (i) Define temporary initial selection and give an explanation as to how it might arise. [3]

(ii) Comment on how the absence of medical questions on a proposal form might affect the impact of temporary initial selection in the context of a life assurance policy. [2]

[Total 5]

- 5 A two-year term assurance policy is issued to a life aged x . Under this policy an immediate payment of 100,000 is made if death occurs in the first year, rising to 150,000 if death occurs in the second year.

Calculate the expected present value of this policy.

Basis:

Mortality $p_x = 0.99$ and $p_{x+1} = 0.975$

The force of mortality can be assumed to be constant over each year of age

Force of Interest 5%

[7]

- 6 (i) Define, showing notation:

- (a) the directly standardised mortality rate;
(b) the indirectly standardised mortality rate.

[4]

- (ii) Calculate the directly and indirectly standardised mortality rates for Occupation A using All Occupations as the standard population.

[4]

	<i>All Occupations</i>		<i>Occupation A</i>	
<i>Age</i>	<i>Population</i>	<i>Mortality rate</i>	<i>Population</i>	<i>Number of deaths</i>
40–49	140,000	0.00169	10,236	125
50–59	156,000	0.00220	11,256	156
60–69	168,000	0.00277	10,633	166
Total	464,000		32,125	447

[Total 8]

- 7 Calculate $\bar{A}_{70:75}$ assuming a constant force of mortality between ages 70 and 71 only.

Basis:

Mortality PMA92C20
Rate of Interest 4% per annum

[8]

- 8 (i) State the main features of a unit-linked policy. [4]

A life insurance company issues a four-year unit-linked policy to a life aged 51 exact. The policy has the following profit vector:

(1798.01, −401.56, −355.10, −1075.23)

- (ii) Determine the net present value of the profits of this policy, assuming that the company sets up reserves in order to zeroise future negative expected cash flows on the policy.

Basis:

Mortality	AM92 Ultimate
Rate of interest on non-unit fund cash flows	2.5% per annum
Risk discount rate	4.5% per annum

[5]

[Total 9]

- 9 A life insurance company issues a three-year policy to a life that offers the following benefits:

- On death during the term of the policy, a sum of 37,500.
- On redundancy during the term of the policy, a return of 105% of total premiums paid.
- On surrender during the term of the policy, a return of 33% of total premiums paid.
- On survival to the end of the term, a sum of 39,000.

Premiums of 12,500 are payable annually in advance throughout the term of the policy or until earlier claim. The death, redundancy and surrender benefits are payable immediately on claim. The policy ceases on payment of any claim.

The company uses the following basis to profit test this policy:

Independent force of mortality	1.5%
Independent force of redundancy	2%
Independent force of surrender	5% in years 1 and 2 only
Interest earned on cash flows	2.5% per annum
Expenses	2.5% of each premium paid
Reserves	Ignore

The company assumes that each force of decrement is constant over each year of age.

- (i) Calculate the dependent rates of mortality, redundancy and surrender for each policy year. [3]

- (ii) Calculate the expected profit margin to the company on this policy using a risk discount rate of 4% per annum. [7]

[Total 10]

- 10** A life insurance company issues whole of life assurance policies to lives aged 35 exact for a sum assured of 85,000 payable at the end of year of death. Premiums are payable annually in advance.

- (a) Calculate the annual office premium for each policy using the basis below.
- (b) Calculate the minimum office premium the company should charge in order that the probability of making a loss on any one policy would be 5% or less.

Basis:

Mortality	AM92 Select
Interest	6% per annum
Initial commission	75% of the annual premium
Initial expenses	350
Renewal commission	2.5% of each annual premium excluding the first
Renewal expenses	85 per annum at the start of the second and subsequent policy years.

[10]

- 11** A pension scheme provides a pension on retirement (through age or ill-health) of one-eightieth of Final Pensionable Salary for each year of pensionable service.

Normal Pension Age is age 65. Final Pensionable Salary is the average annual salary in the three years before retirement.

- (i) Draw a transition state model for the pension scheme fully labelling the diagram. [6]
- (ii) Calculate the expected present value of the total retirement benefits for a life aged 50 exact with salary in the previous year of 30,000 and 10 years of past service.

Basis: Pension Scheme Table in the Formulae and Tables for Examinations. [4]
[Total 10]

- 12** A life insurance company issues with-profits whole of life policies to lives aged 35 exact with the sum assured of 100,000 together with any attaching bonuses payable immediately on death of the life assured. Level premiums are payable monthly in advance to age 65 or until earlier death.

The company markets two versions of this policy as follows:

Version A – assumed to provide compound bonuses of 4% of the sum assured vesting at the end of each policy year.

Version B – assumed to provide simple bonuses of $b\%$ per annum of the sum assured, again vesting at the end of each policy year.

The death benefit under each version does not include any bonus relating to the policy year of death.

The following basis is used to price these contracts:

Mortality	AM92 Select
Rate of Interest	4% per annum
Initial expenses	275
Renewal expenses	2.5% of the second and subsequent monthly premiums
Initial commission	40% of the total premiums payable in the first policy year, all incurred at the policy commencement date
Renewal commission	2.5% of the second and subsequent monthly premiums
Claim expenses	225 at payment of death claim

- (a) Show that the monthly premium under version A of this policy is approximately 511.
- (b) Calculate the level simple bonus rate b that can be supported each year under version B of this policy if the monthly premium calculated in part (a) is charged.

[10]

13 A life insurance company issued 25-year decreasing term assurance policies on 1 January 2001 to lives then aged 40 exact. The death benefit, payable at the end of the year of death, is 500,000 in the first policy year, 480,000 in the second policy year thereafter reducing by 20,000 each year until the benefit is 20,000 in the twenty-fifth and final policy year. Premiums on the policies are payable annually in advance for 25 years or until earlier death.

- (a) Show that the annual net premium per policy is approximately 643 using the basis below.
- (b) Calculate the mortality profit or loss to the life insurance company during 2017 using the basis below if 1,527 policies were in force at the start of that year and 9 policyholders died during the year.

Basis:

Mortality	AM92 Ultimate
Rate of Interest	4% per annum

[11]

END OF PAPER