

INSTITUTE AND FACULTY OF ACTUARIES



EXAMINATION

13 April 2016 (am)

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. *Mark allocations are shown in brackets.*
4. *Attempt all 13 questions, beginning your answer to each question on a new page.*
5. *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 ${}_{0.5}p_{90.25}$ using the method of Uniform Distribution of Deaths. Show all your workings.

Basis:

Mortality ELT15 (Males)

[3]

- 2** (i) State the two conditions under which the net premium prospective reserve will equal the net premium retrospective reserve. [2]

(ii) Describe two reasons why these conditions are unlikely to hold in practice.

[2]

[Total 4]

- 3** Calculate:

(a) ${}_{25}P_{30}$

(b) $\ddot{a}_{[40]:\overline{15}}^{(4)}$

(c) $A_{50:\overline{20}}^1$

Basis:

Mortality AM92

Rate of interest 4% per annum

[4]

- 4** Describe with examples how selection applies to decrements experienced by members of a pension scheme.

[6]

5 The table below shows an extract from a study of mortality for a small country:

<i>Age</i>	<i>Population</i>	<i>Number of deaths</i>
60	9,950	52
61	8,020	68
62	6,997	73

(i) Show that the standardised mortality ratio using ELT15 (Males) as the standard population is 0.5. It can be assumed that the age definition of the country matches that of ELT15 (Males). [4]

(ii) Explain what the result in part (i) indicates. [2]

[Total 6]

6 (i) Prove that $\bar{A}_{x:n} = 1 - \delta \bar{a}_{x:n}$ for the following basis. [3]

Basis:

Force of mortality μ_x is constant for all x

Force of interest δ throughout

An endowment assurance pays a sum assured of 10,000 immediately on death or on survival to the end of the term of the policy.

(ii) Calculate, showing all your workings, the premium payable continuously for a life aged 40 exact for an endowment assurance with a term of 20 years. [4]

Basis:

Mortality $\mu_x = .01$ for all x

Rate of interest 5% per annum

[Total 7]

- 7** A five year unit-linked policy issued by an insurance company to a life aged 60 exact has the following profit vector:

(751.25, -321.06, -267.57, -192.05, 201.75)

- (i) Define the meaning of zeroisation in the context of this unit linked policy. [1]
- (ii) Explain why an insurance company might choose to zeroise the above profit vector. [1]
- (iii) Calculate, showing all your workings, the net present value of the profits of this policy after zeroisation.

Basis:

Mortality	AM92 Ultimate
Rate of interest on non-unit fund cash flows	3.5% per annum
Risk discount rate	6.0% per annum

[5]

[Total 7]

- 8** A company provides its employees with a benefit on disability before age 65. The benefit is a life annuity of 50% of salary at the date of disability.

- (i) Draw and label a transition state diagram for this benefit. [4]
- (ii) Derive a formula for the expected present value of this benefit for a life aged x with a current annual salary of 20,000. [3]

[Total 7]

- 9** A company provides a cash benefit of five times salary on disability before retirement where normal retirement age is 65.

Determine the expected present value of this benefit for a life aged 63 exact with current annual salary of 50,000 stating all your assumptions.

Basis:

Independent force of mortality	ELT15 (Males)
Independent force of disability	0.03
Discount rate	5% per annum
Salary increase	3% at age 64

[8]

10 A life insurance policy for a male life aged 55 exact provides the following benefits:

- 50,000 payable immediately on his death, if this occurs before the age of 65 exact.
- On survival to age 65 exact, a refund of 25% of total premiums paid without interest.
- On death of the male at any time, a pension of 5,000 per annum is payable monthly in advance to his widow (who is 5 years younger than him) for the remainder of her life, should she survive him. (This benefit is available throughout the lifetime of the male.)

The policy is funded by premiums payable annually in advance for five years, or until the death of the male life, if earlier.

Basis:

Male mortality	PMA92C20
Female mortality	PFA92C20
Rate of interest	4 % per annum
Expenses	Nil

Calculate, showing all your workings, the premium for this policy. [9]

11 On 1 January 2012, a life insurance company issued joint life whole life assurance policies. Each policy was issued to a male life aged 65 exact and a female life aged 60 exact. A sum assured of 75,000 is payable immediately on the death of the second of the lives to die.

Premiums of 1,395.11 are payable annually in advance for each policy while at least one of the lives is alive.

At the beginning of 2014, there were 5997 policies in force. For all of these policies, both lives were still alive. During 2014, the following experience was observed:

- for 2 policies, both lives died
- for 12 policies, only the male life died
- for 8 policies, only the female life died

Calculate, showing all your workings, the mortality profit or loss for the group of policies for the calendar year 2014.

Basis:

Mortality	PMA92C20 for the male PFA92C20 for the female
Rate of interest	4% per annum
Expenses	Ignore

[10]

- 12** On 1 March 1997, a life insurance company issued a whole life with profit policy to a life then aged 45 exact. The basic sum assured was 150,000. The sum assured (together with any bonuses attaching) is payable immediately on death. Level premiums are payable monthly in advance to age 85 or until earlier death. Compound reversionary bonuses vest at the beginning of each policy year (i.e. the death benefit includes any bonus relating to the policy year of death).

The company calculates the premium on the following basis:

Mortality	AM92 Select
Rate of interest	6% per annum
Initial expenses	70% of the first year's premium, incurred at the outset
Renewal expenses	5% of the second and each subsequent year's premium, incurred at the beginning of the respective policy years
Bonuses:	1.92308% per annum compound

- (i) Show that the monthly premium is approximately 276. [7]

On 28 February 2015, the company alters the policy at the request of the policyholder to a paid-up policy with no future premiums payable. The sum assured under the policy is reduced, with no further bonuses payable.

The company calculates the reduced sum assured after alteration by equating prospective gross premium policy reserves immediately before and after alteration, allowing for an expense of alteration of 175.

The company calculates prospective gross premium policy reserves for the purpose of the alteration using the following basis:

Mortality	AM92 Ultimate
Rate of interest	6% per annum
Expenses	ignore
Future bonuses	ignore

Bonuses have vested at a rate of 2% per annum compound at the beginning of each policy year from the date of issue of the policy.

- (ii) Calculate, showing all your workings, the sum assured for the policy after alteration. [6]
[Total 13]

- 13** On 1 January 2015, a life insurance company issued four year increasing term assurance policies with level premiums payable annually in advance for the term of the policy, but ceasing on earlier death. The initial sum assured is 140,000, increasing by 20,000 at each policy anniversary (the first increase taking place at the beginning of the second policy year). The death benefit is payable at the end of the year of death. If the policyholder survives to the end of the term of the contract, 50% of the total premiums paid (accrued with no interest) is payable.

The company calculates the premium on the following basis:

Mortality	AM92 Select
Rate of interest	6% per annum
Initial expense	275
Initial commission	30% of the first year's premium, incurred at the outset
Renewal expense	55 per annum, incurred at the time of payment of the second and subsequent years' premiums
Renewal commission	2.5% of the second and subsequent years' premiums

For a male life aged 56 exact at inception of the policy:

- (i) Set out, in stochastic form, the gross future loss random variable at the outset of this policy using where applicable, T_x , K_x and elements of the premium basis that are relevant. [3]
- (ii) Calculate, showing all your workings, the office premium using annuity and assurance functions and setting the expected present value of the gross future loss random variable equal to zero. [4]
- (iii) Calculate, showing all your workings, the office premium using a discounted cash flow projection, assuming no surrenders, ignoring reserves and using the same profit criterion as in part (ii) above. The discount rate is assumed to be 6% per annum. [6]
- (iv) Explain, without further calculations, the effect of:
 - (a) allowing for the setting up of reserves for the calculation in (iii).
 - (b) having set up reserves in (iv) (a), increasing the discount rate to 8% per annum.

[3]

[Total 16]

END OF PAPER