INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

26 April 2011 (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 separate sheet.*

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 Give a different example of selection shown by each of the following mortality tables:

(a) ELT15
(b) PMA92
(c) AM92

[3]

2 Calculate:

(a) ${}_{23}p_{65}$
(b) ${}_{10|5}q_{60}$
(c) $\ddot{s}_{65:\overline{10}|}$

Basis:
Mortality PMA92C20
Rate of interest 4% per annum [4]

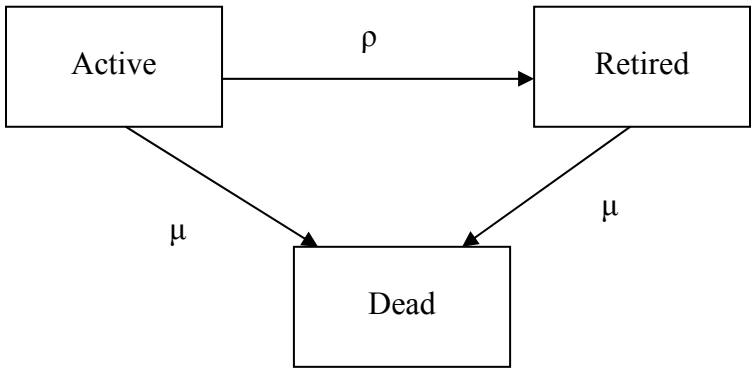
3 Calculate $(I\overline{a})_x$

Basis: $\mu_x = 0.02$ for all x
$\delta = 4\%$ per annum

[4]

4 Outline the benefits that are usually provided by a pension scheme on retirement due to ill health. [5]

5 A pension scheme uses the following model to calculate probabilities, where the transition intensities are $\mu = 0.05$ and $\rho = 0.08$.



Calculate:

(a) the dependent probability of retirement
(b) the independent probability of death from active service

using the Kolmogorov equations. [5]

6 (i) Define uniform distribution of deaths [2]

(ii) Using the method in (i) above calculate ${}_{1.25}q_{65.5}$ [4]

Basis:
Mortality ELT15(Males) [Total 6]

7 Explain how education influences morbidity. [6]

8 A life insurance company issues a with profits whole life assurance policy to a life aged 40 exact. The sum assured of £100,000 plus declared reversionary bonuses are payable immediately on death. Level premiums are payable annually in advance to age 65 or until earlier death.

A simple bonus, expressed as a percentage of the sum assured, is added to the policy at the start of each year (i.e. the death benefit includes the bonus relating to the policy year of death).

The following basis is used to price this policy:

Mortality	AM92 Select
Rate of Interest	4% per annum
Initial expenses	£300 plus 50% of the first annual premium, incurred at the policy commencement date
Renewal commission	2.5% of each premium from the start of the second policy year
Claim expense	£350 at termination of the contract

Using the principle of equivalence, calculate the level simple bonus rate that can be supported each year on this policy if the annual premium is £3,212. [6]

9 A male life aged 52 exact and a female life aged 50 exact take out a whole life assurance policy. The policy pays a sum assured of £100,000 immediately on first death. Premiums are payable for a period of five years, monthly in advance.

Calculate the monthly premium payable.

Basis:

Mortality	PMA92C20 (male life), PFA92C20 (female life)
Rate of interest	4% per annum
Expenses	Nil

[7]

10 Calculate the expected present value and variance of the present value of an endowment assurance of 1 payable at the end of the year of death for a life aged 40 exact, with a term of 15 years.

Basis:

Mortality	AM92 Select
Rate of interest	4% per annum
Expenses	Nil

[8]

11 A life insurance company issues a 4-year unit-linked endowment policy to a life aged 61 exact under which level premiums of £2,500 are payable yearly in advance throughout the term of the policy or until earlier death. In the first policy year 40% of the premium is allocated to units, while in the second and subsequent policy years 110% of the premium is allocated to units. The unit prices are subject to a bid-offer spread of 5%.

If the policyholder dies during the term of the policy, the death benefit of £10,000 or the bid value of the units, whichever is higher, is payable at the end of the policy year of death.

The policyholder may surrender the policy, in which case a value equal to a fixed percentage of the total premiums paid on the policy is payable at the end of the policy year of surrender. The percentage is based on the policy year of surrender as follows:

Policy year	*% of total premiums payable as a surrender value*
1	0
2	25
3	50
4	75

On maturity, 105% of the bid value of units is payable.

An annual management charge of 0.5% of the bid value of units is deducted at the end of each policy year before death, surrender and maturity benefits are paid.

The company uses the following assumptions in carrying out profit tests of this contract:

Rate of growth on assets in the unit fund	4.25% per annum
Rate of interest on non-unit fund cash-flows	3.5% per annum
Independent rate of mortality	AM92 Select
Independent rate of surrender	6% per annum
Initial expenses	£325
Renewal expenses	£74 per annum on the second and subsequent premium dates
Initial commission	10% of first premium
Renewal commission	2.5% of the second and subsequent years' premiums
Risk discount rate	5.5% per annum

(i) Construct a multiple decrement table for this policy assuming that there is a uniform distribution of both decrements over each year of age in the single decrement table. [3]

(ii) Construct tables showing the growth of the unit fund and the non-unit fund. Include all commissions in the non-unit fund. [7]

(iii) Calculate the profit margin for this policy on the assumption that the company does not zeroise future expected negative cashflows. [3]

[Total 13]

12 On 1 April 1988, a life insurance company issued a 25-year term assurance policy to a life then aged 40 exact. The initial sum assured was £75,000 which increased by 4% per annum compound at the beginning of the second and each subsequent policy year. The sum assured is payable immediately on death and level monthly premiums are payable in advance throughout the term of the policy or until earlier death.

The company uses the following basis for calculating premiums and reserves:

Mortality	AM92 Select
Rate of interest	4% per annum
Initial commission	50% of the total premium payable in the first policy year
Initial expenses	£400 paid at the policy commencement date
Renewal commission	2.5% of each premium from the start of the second policy year
Renewal expenses	£75 per annum, inflating at 4% per annum compound, at the start of the second and subsequent policy years (the renewal expense quoted is as at the start of the policy and the increases due to inflation start immediately)
Claim expense	£300 on termination (the claim expense is fixed over the duration of the policy)

(i) Show that the monthly premium for the policy is approximately £56. [10]

(ii) Calculate the gross premium prospective reserve as at 31 March 2011. [6]

[Total 16]

13 (i) Explain, including formulae, the following expressions assuming that the sum assured is payable at the end of the year of death:

- death strain at risk
- expected death strain
- actual death strain [6]

(ii) A life insurance company issues the following policies:

- 25-year term assurances with a sum assured of £200,000
- 25-year endowment assurances with a sum assured of £100,000

The death benefit under each type of policy is payable at the end of year of death.

On 1 January 2000, the company sold 10,000 term assurance policies to male lives then aged 40 exact and 20,000 endowment assurance policies to male lives then aged 35 exact. For each type of policy, premiums are payable annually in advance.

During the first ten years, there were 145 actual deaths from the term assurance policies written and 232 actual deaths from the endowment assurance policies written.

(a) Calculate the death strain at risk for each type of policy during 2010.

During 2010, there were 22 actual deaths from the term assurance policies and 36 actual deaths from the endowment assurance policies.

Assume that there were no lapses/withdrawals on each type of policy during the first eleven years.

(b) Calculate the total mortality profit or loss to the office in the year 2010.

(c) Comment on the results obtained in (b) above.

Basis:

Mortality	AM92 Ultimate
Rate of interest	4% per annum
Expenses	Nil

[11]
[Total 17]

END OF PAPER