INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

27 April 2015 (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. *Mark allocations are shown in brackets.*

4. *Attempt all 14 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.

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1 Calculate $A_{50:\overline{4}|}$.

Basis:

Mortality $q_{50} = 0.05$
$q_{51} = 0.06$
$q_{51+t} = 1.1q_{50+t}$ for $t \geq 1$

Interest 6% per annum [3]

2 Describe how the quality of housing affects mortality and morbidity. [3]

3 Suppose α and β are the only two independent modes of decrement and $\mu_x^{\beta} = \frac{1}{4}\mu_x^{\alpha}$

Express $(aq)_x$ in terms of μ_x^{β}. [3]

4 Calculate:

(a) ${}_{10|15}q_{60}$

(b) ${}_{12}p_{[50]+1}$

(c) $a^{(4)}_{40:\overline{10}|}$

Basis:

Mortality AM92
Interest 6% per annum [4]

5 Draw a multiple state model diagram for the parameters involved using the service table from the PEN tables on Page 142 of the Formulae and Tables for Examinations and labelling your diagram clearly. [5]

6 A life aged 55 exact purchases a 3-year term assurance with sum assured of £150,000 payable if death occurs during the term of the policy. Level premiums of £900 are payable annually in advance throughout the term of the policy or until earlier death. The death benefit is payable at the end of the policy year of death.

Calculate the expected present value of the profit or loss to the office on the contract.

Basis:

Mortality	AM92 Select
Interest	3% per annum
Initial expenses	£260
Renewal expenses	£70 per annum incurred at the start of both the second and third policy year

Assume no reserves are required for this policy. [6]

7 Calculate ${}_{1.75}p_{82.75}$.

(a) Using the method of Uniform Distribution of Deaths.

(b) Using the method of Constant Force of Mortality.

Basis:

Mortality ELT15(Males) [6]

8 (a) Explain why lives are subdivided into separate groups for the analysis of mortality.

(b) Suggest three types of selection with an example for each. [7]

9 On 1 January 1999, an insurance company issued a without profit whole life policy to a life aged 45 exact. The sum assured on the policy is £125,000 which is payable at the end of the year of death. Level premiums are payable annually in advance to age 65 or until earlier death. The company calculated the premium on the following basis:

Mortality	AM92 Select
Interest	6% per annum
Initial expenses	75% of the first year's premium, incurred at outset
Renewal expenses	5% of the second and each subsequent year's premium, incurred at the beginning of the respective policy years
Claims expense	£325 payable at the end of the year of death

(i) Show that the annual premium is approximately £1,883. [4]

On 31 December 2013, immediately before the premium then due, the life wishes to surrender the policy. The insurance company calculates a surrender value equal to the gross prospective policy reserve, using the following basis:

Mortality	AM92 Ultimate
Interest	6% per annum
Expenses	Ignore

(ii) Calculate the surrender value payable by the insurance company. [3]

[Total 7]

10 (i) Calculate: $\overline{A}^{\,1}_{40:50}$. [2]

Basis:

Mortality	$\mu_x = 0.04$ throughout life for the life aged 40
	$\mu_x = 0.06$ throughout life for the life aged 50
Rate of interest	5% per annum

Two lives aged 40 and 50 exact purchase a policy with the benefit in part (i) above and a sum assured of 75,000. The benefit is funded by a premium payable continuously for a 30-year period or until the first death if earlier. The premium is paid at a level annual rate for the first 20 years, then reduces by 25% to be paid at the lower level annual rate for the remainder of the period.

(ii) Calculate the initial level annual premium using the basis in part (i) above. [6]

[Total 8]

11 A special joint life annuity is issued to a male life now aged 65 exact and a female life now aged 62 exact. The annuity is payable monthly in arrear and is subject to the following conditions:

- The amount of the annuity while both lives survive is 100,000 per annum.
- If the male life dies first leaving the female life surviving the annuity reduces to 50,000 per annum payable until she dies.
- If the female life dies first leaving the male life surviving the annuity reduces to 75,000 per annum payable until he dies.
- In addition if either life is alive at the 10^{th} and 20^{th} anniversaries of the policy a cash lump sum of 20,000 is paid at each date.

Calculate the expected present value of the annuity.

Basis:

Mortality	PMA92C20 and PFA92C20
Interest	4% per annum
Expenses	Nil

[9]

12 An insurance company issues a 25-year with-profit endowment assurance policy to a life aged 40 exact. The sum assured of £75,000 plus declared reversionary bonuses are payable on survival to the end of the term or immediately on death if earlier.

The insurance company assumes that future reversionary bonuses will be declared at a rate of 3% of the sum assured, simple and vesting at the end of each policy year (i.e. the death benefit does not include any bonus relating to the policy year of death). Premiums are payable in advance throughout the term of the policy or until earlier death.

Calculate the monthly premium.

Basis:

Mortality	AM92 Select
Interest	6% per annum
Initial commission	115% of the first monthly premium
Initial expenses	£210
Renewal commission	2.5% of each monthly premium payable excluding the first
Renewal expenses	£85 per annum, inflating at 1.92308% per annum compound, at the start of the second and subsequent policy years.
Inflation	For renewal expenses, the amount quoted is at outset, and the increases due to inflation start immediately.

[9]

13 On 1 January 2004, an insurance company issued 15-year temporary assurance policies to 3,000 lives then aged 45 exact. For each policy, the sum assured is £100,000 for the first 10 years, and £40,000 thereafter. The sum assured is payable immediately on death and level annual premiums are payable in advance throughout the term or until earlier death.

Basis:

Mortality	AM92 Ultimate
Interest	4% per annum

(i) Show that the annual premium payable for each policy is approximately £233 using the basis above. [4]

(ii) Calculate the reserve per policy as at 31 December 2013, assuming the reserving basis is the same as the premium basis. [3]

(iii) (a) Describe the disadvantages to the insurance company of issuing this policy.

(b) Suggest two examples of how the terms of the policy could be altered so as to remove these disadvantages. [4]

There were 122 deaths between 2004 and 2012 inclusive and a further 12 deaths in 2013.

(iv) Calculate the mortality profit or loss to the insurance company in 2013 on the basis above. [2]

[Total 13]

14 A life insurance company issues a three-year unit-linked endowment assurance policy to a life aged 58 exact under which level premiums of £3,000 are payable annually in advance throughout the term of the policy or until earlier death. The premium allocation rate (%) at time t is given by:

$[75 + 20t]$ where $t = 0$, 1 and 2.

The units are subject to a bid-offer spread of 5%. An annual management charge of 0.75% of the bid value of units is deducted at the end of each policy year.

Management charges are deducted from the unit fund before any death, surrender or maturity benefits are paid.

If the policyholder dies during the term of the policy, the death benefit of £9,000 or the bid value of the units if higher, is payable at the end of the policy year of death. The policyholder may surrender the policy only at the end of each policy year. On surrender at the end of the policy year or on survival to the end of the term, the current bid value of the units is payable.

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

Rate of growth on assets in the unit fund	4% per annum
Rate of interest on non-unit fund cash flows	2% per annum
Mortality	AM92 Select
Surrender	10% at the end of first, second and third policy years only
Initial expenses	£275
Renewal expenses	£70 per annum on the second and subsequent premium dates
Initial commission	5% of first premium
Renewal commission	2% of the second and subsequent years' premiums
Risk discount rate	6% per annum

(i) Calculate the profit margin for the policy on the assumption that the company does not zeroise future expected negative cash flows. [13]

Suppose the company sets up reserves in order to zeroise future negative expected cash flows.

(ii) Calculate the profit margin for the policy allowing for the cost of setting up these reserves. [4]

[Total 17]

END OF PAPER