

# INSTITUTE AND FACULTY OF ACTUARIES

## EXAMINATION

23 April 2012 (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 15 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.*

<p><i>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.</i></p>
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- 1 (a) Define  ${}_{4|5}q_{[60]+1}$  in words.  
 (b) Calculate its value.

Basis:

Mortality AM92 [3]

- 2 Under a policy issued by a life insurance company, the death benefit payable at the end of year of death is a return of premiums paid without interest. A level premium of £3,000 is payable annually in advance throughout the term of the policy.

For a policy in force at the start of the 12<sup>th</sup> policy year, you are given the following information:

Reserve at the start of the policy year	£25,130
Reserve at the end of the policy year per survivor	£28,950
Probability of death during the policy year	0.03
Expenses incurred at the start of the policy year	£90
Rate of interest earned	4% per annum

Reserves given above are immediately before payment of the premium due.

Calculate the profit/loss expected to emerge at the end of the 12<sup>th</sup> policy year per policy in force at the start of that year. [3]

- 3 Calculate:

- (a)  $a_{50:\overline{15}|}$   
 (b)  $(IA)_{50:\overline{15}|}^1$

Basis:

Mortality AM92  
 Rate of interest 6% per annum [4]

- 4 A joint life assurance contract provides a death benefit of £100,000 payable immediately on the second death of two lives, a male life currently aged 60 exact and a female life currently aged 55 exact.

Calculate the expected present value of the contract.

Basis:

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

**5** A 10-year unit-linked policy has the following profit vector:

$(-40, -12, -6, -1, 5, -4, 8, 20, 25, 30)$

Determine the revised profit vector if reserves are set up to zeroise future negative cash flows on the following basis:

Mortality 0.5% per annum (i.e. probability of death at each age)  
Interest 2.5% per annum

[4]

**6** (a) Calculate the constant force of mortality applicable to a life aged between 67 and 68 exact.

(b) Calculate the value of  ${}_{0.5}q_{67.25}$  using the assumption of a constant force of mortality and the value derived in (a) above.

Basis: AM92 Ultimate

[4]

**7** Describe the benefits typically provided by a salary-related pension scheme for active members on age retirement. [6]

**8** Explain the impact of occupation on mortality and morbidity. [6]

**9** (i) List the main categories of expenses incurred by life insurance companies. [2]

(ii) Give one example of each category in part (i) and indicate the manner in which it is usually allowed for in the calculation of premiums. [4]

[Total 6]

**10** An insurance company writes policies that provides benefits of £1,000 in the event of becoming disabled due to accident and £10,000 on death.

(a) Construct a multiple state transition model for these policies.

(b) Give a formula for the expected present value of the benefits.

[6]

- 11** (i) State the advantages and disadvantages of using crude mortality rates and directly standardised mortality rates as the comparison measure of mortality in two or more different populations [4]

You are given the following data in respect of a sub-population:

<i>Age</i>	<i>Population</i>
50	100,000
55	95,000
60	80,000

Number of deaths in sub-population      1,250

- (ii) Calculate the Standardised Mortality Ratio using ELT15 (Males) as the mortality rate for the standard population. [3]  
[Total 7]

- 12** An endowment assurance contract with a term of 10 years pays a sum assured of £100,000 immediately on death and a sum of £50,000 on survival for 10 years.

Calculate the expected present value and variance of this contract.

Basis:

Mortality       $\mu_x = 0.03$  throughout  
Rate of interest      5% per annum [8]

- 13** A life insurance company issues a 40-year with profit endowment assurance policy to a life aged 20 exact. The sum assured of £85,000 plus declared reversionary bonuses is payable on survival to the end of the term or immediately on death if earlier.

The company assumes that future annual bonuses will be declared at a rate of 1.92308% of the sum assured, compounded 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).

Calculate the monthly premium payable in advance throughout the term of the policy.

Basis:

Mortality      AM92 Select  
Interest      6% per annum  
Initial commission      480% of the first monthly premium  
Initial expenses      £325  
Renewal commission      2.5% of each monthly premium excluding the first  
Renewal expenses      £75 per annum at the start of the second and subsequent  
policy years. The renewal expense is assumed to increase  
by £5 per annum from the start of the third policy year. [10]

- 14** A life insurance company issues 20-year decreasing term assurance policies to single lives aged 40 exact. The death benefit, which is payable at the end of the year of death, is £200,000 in the first policy year, £190,000 in the second policy year thereafter reducing by £10,000 each year until the benefit is £10,000 in the twentieth and final policy year. Premiums on the policies are payable annually in advance for 20 years or until earlier death.

The company calculates its reserves on a net premium basis and negative reserves are permitted.

- (i) Show that the annual net premium for each policy is approximately equal to £204 using the basis below. [4]

625 policies were in force at the start of the 10<sup>th</sup> policy year and 3 policyholders died during that policy year.

- (ii) Calculate the mortality profit or loss to the life insurance company during the 10<sup>th</sup> policy year using the basis below. [6]
- (iii) Comment briefly on the results obtained in part (ii) above. [2]

Basis:

Mortality	AM92 Ultimate
Interest	4% per annum
Expenses	Nil

[Total 12]

- 15** A life insurance company issues a three-year term assurance policy to a male life aged 57 exact under which level premiums are payable annually in advance throughout the term of the policy or until earlier death. The sum assured is £150,000 payable at the end of year of death.

The company uses the following assumptions to calculate the premium for this policy:

Rate of interest on cash flows	6% per annum
Mortality	AM92 Select
Initial expenses	£350
Renewal expenses	£50 per annum on the second and third premium dates
Initial commission	15% of first premium
Renewal commission	2.5% of the second and third years' premiums
Risk discount rate	6% per annum

- (i) Write down the gross future loss random variable at the outset of the policy. [5]
- (ii) Calculate the office premium using assurance and annuity functions, setting the expected value of the gross future loss random variable to zero. [4]
- (iii) Derive the office premium using a discounted cash flow projection, assuming no withdrawals and using the same profit criterion as in part (ii). [6]
- (iv) Without further calculation explain the effect of:
- (a) setting up reserves within the calculation of part (iii).
- (b) having set up the reserves in part (a), increasing the risk discount rate to 8% per annum.

[2]

[Total 17]

**END OF PAPER**