

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

2 October 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 Calculate:

(a) ${}_{12}P_{43}$

(b) ${}_{10|5}q_{55}$

(c) $\ddot{a}_{45:\overline{10}|}$

Basis:

Mortality	AM92	
Rate of interest	6% per annum	[3]

2 Give three different forms of selection that would be expected in a group of lives purchasing immediate annuities with an example of each. [3]

3 Explain how nutrition affects mortality and morbidity. [4]

4 Calculate ${}_3p_{55.75}$ using the assumption of Uniform Distribution of Deaths.

Basis:

Mortality	ELT15 (Females)	[4]
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5 The Area Comparability Factor is defined as:

$$F = \frac{\sum_x {}^sE_{x,t}^c {}^sm_{x,t}}{\sum_x {}^sE_{x,t}^c} \bigg/ \frac{\sum_x E_{x,t}^c {}^sm_{x,t}}{\sum_x E_{x,t}^c}$$

(a) Define the notation used.

(b) Explain what is measured by the Area Comparability Factor by considering the ratio of the numerator to the denominator.

[4]

6 A life insurance company issues a with profit whole life assurance policy to a life aged 40 exact, under which the sum assured S and any attaching bonuses, are payable immediately on death. Compound bonuses are added annually in advance. Premiums are payable annually in advance ceasing at exact age 85 or on earlier death.

Write down an expression for the net future loss random variable at outset for this policy defining all symbols that are used. [4]

- 7** On 1 January 2007, a life insurance company sold a large number of 30-year pure endowment policies to lives then aged 35 exact. The sum assured under each policy is £125,000 payable on maturity. Premiums are payable annually in advance throughout the term of the policy.

There were 3521 pure endowment policies still in force on 1 January 2011 and 8 policyholders died during 2011.

Calculate the total mortality profit or loss to the life insurance company during 2011 assuming the company calculates net premium reserves on the following basis:

Mortality	AM92 Select
Interest	4% per annum
Expenses	Nil

[4]

- 8** Examine the column of d_x shown in the English Life Table No. 15 (Males) in the Formulae and Tables for Examinations (Pages 68–69).

Describe the key characteristics of this mortality table using the data to illustrate your points. [6]

- 9** (i) Explain what is meant by the following in the context of life insurance policies:

- (a) gross premium prospective reserve
- (b) gross premium retrospective reserve

[4]

- (ii) State the conditions necessary for gross premium prospective and gross premium retrospective reserves to be equal.

[3]

[Total 7]

- 10** A pension scheme provides a lump sum benefit to members on reaching retirement at age 65 equal to one month's pensionable salary for each complete year of service. Pensionable salary is defined as average annual salary in the last two years before retirement.

Calculate the cost of this benefit as a percentage of salary for a new member of the scheme aged 35 exact, with salary in the next year of £20,000.

Basis:

Pension Scheme tables in the Formulae and Tables for Examinations

Interest 4% per annum

[8]

- 11** A special joint life annuity of £500 per week is payable in arrear in respect of a male life aged 65 exact and a female life aged 62 exact. The annuity has the following features:
- The annuity is guaranteed in any event for the first 5 years at the level of £500 per week.
 - At the end of the guarantee period if both lives are still surviving the annuity continues at the same level until one life dies at which time it reduces to two-thirds of the initial level and continues at this reduced level until the second life dies.
 - At the end of the guarantee period if only one life has survived the annuity reduces to two-thirds of the initial level and continues at this reduced level until the second life dies.
 - At the end of the guarantee period if both lives have previously died then the annuity ceases.

Calculate the expected present value of this annuity.

Basis:

Mortality	PMA92C20 (male life), PFA92C20 (female life)	
Rate of interest	4% per annum	
Expenses	Nil	[8]

- 12** A life insurance company issues a special endowment assurance policy for a 25 year term to two lives x and y . Under this policy, a sum assured of £100,000 is paid immediately on the second death within the 25 year term. At the end of 25 years a sum of £50,000 is paid to each survivor.

Calculate the annual premium paid continuously under this policy assuming this is paid throughout the term or until the second death if earlier.

Basis:

Mortality	Life x : $\mu_x = 0.02$ for all x Life y : $\mu_y = 0.03$ for all y	
Force of interest	5% per annum	
Expenses	Nil	[10]

- 13** A life insurance company issues a with profit whole life assurance policy to a life aged 55 exact. The sum assured is £75,000 together with any attaching bonuses and is payable immediately on death. Level premiums are payable monthly in advance ceasing on the policyholder's death or on reaching age 85 if earlier.

Simple annual bonuses are added at the end of each policy year (i.e. the death benefit does not include any bonus relating to the policy year of death).

The company calculates the premium on the following basis:

Mortality	AM92 Select
Interest	4% per annum
Expenses	
Initial	£275
Renewal	£65 at the start of the second and subsequent policy years and payable until death
Claim	£200 on death
Commission	
Initial	75% of the total premium payable in the first policy year
Renewal	2.5% of the second and subsequent monthly premiums
Bonuses	Simple bonus of 2.0% of basic sum assured per annum

- (i) Calculate the monthly premium for this policy. [6]
- (ii) Calculate the gross prospective policy value at the end of the 30th policy year given that the total actual past bonus additions to the policy have followed the assumptions stated in the premium basis above (including the bonus just vested).

Policy value basis:

Mortality	AM92 Ultimate
Interest	4% per annum
Expenses	
Renewal	£80 at the start of each policy year and payable until death
Claim	£250 on death
Commission	
Renewal	2.5% of the monthly premiums
Bonuses	Simple bonus of 2.5% of basic sum assured per annum

[4]

[Total 10]

14 A life insurance company issues a four-year policy to a male life aged 30 exact that offers the following benefits:

- On death during the term of the policy or on survival to the end of the term, a sum of £60,000.
- On redundancy during the term of the policy, a return of 100% of total premiums paid.
- On surrender during the term of the policy, a return of 50% of total premiums paid.

Premiums of £14,000 are payable annually in advance throughout the term of the policy or until earlier claim. The death, surrender and redundancy benefits are payable immediately on claim. The contract ceases on payment of any claim.

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

Interest earned on cash flows	3% per annum
Expenses	5% of each premium paid
Reserves	Ignore

The company has also calculated the following dependent rates of mortality, surrender and redundancy which are used to profit test this contract:

Year t	$(aq)_{[30]+t-1}^d$	$(aq)_{30+t-1}^s$	$(aq)_{30+t-1}^r$
1	.000447	.098727	.023744
2	.000548	.049361	.024368
3	.000602	.024680	.024680
4	.000636	0	0

Calculate the expected profit margin to the company on this policy using a risk discount rate of 5% per annum. [10]

15 A life insurance company issues a three-year unit-linked endowment assurance policy to a male life aged 45 exact. The main features of the contract are:

Premiums:	£3,000 per annum are payable yearly in advance throughout the term of the policy or until earlier death
Allocation rates:	75% of premium is allocated to units in the first policy year, 100% in the second and 105% in the third
Policy fee:	£35 is deducted from the bid value of units at the start of each policy year
Death benefit:	150% of the bid value of the units is payable at the end of the policy year of death
Maturity benefit:	100% of the bid value of the units is payable

Bid-offer spread: 5%

Annual management charge: 1.5% of the bid value of units is deducted at the end of each policy year (management charges are deducted from the unit fund before death 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	5.0% per annum in year 1 4.5% per annum in year 2 4.0% per annum in year 3
Rate of interest on non-unit fund cash flows	3.0% per annum
Mortality	AM92 Select
Withdrawals	None
Initial expenses	£275
Renewal expenses	£80 per annum on the second and subsequent premium dates
Initial commission	20% of first premium
Renewal commission	2.5% of the second and subsequent years' premiums
Rate of expense inflation	2.0% per annum
Risk discount rate	6.5% per annum

For renewal expenses, the amount quoted is at outset, and the increases due to inflation start immediately.

- (i) Calculate the non-unit fund cash flows in each year of the contract and hence the expected present value of profit assuming that the policyholder dies in the third year of the contract. [9]
- (ii) Calculate the expected present value of profit for the policy if the policyholder dies in the:
- (a) first year of the contract.
- (b) second year of the contract. [4]
- (iii) Hence calculate the expected present value of the contract allowing for the possibility that the policyholder survives to the end of the contract. [2]
- [Total 15]

END OF PAPER