

EXAMINATION

6 October 2010 (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 14 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>
--

- 1** Calculate:
- (a) ${}_{20|10}q_{[45]}$
- (b) ${}_{30}P_{[45]:[50]}$
- Basis: AM92 Select
- [3]

- 2** Calculate ${}_{0.5}p_{45.75}$ using the Uniform Distribution of Deaths assumption.
- Basis: AM92 Ultimate
- [3]

- 3** Calculate the single premium payable for a temporary reversionary annuity of £12,000 per annum payable monthly in arrear to a female life currently aged 55 exact on the death of a male life currently aged 50 exact. No payment is made after 20 years from the date of purchase.
- Basis:
- | | |
|--------------------------|--------------|
| Rate of interest | 4% per annum |
| Mortality of male life | PMA92C20 |
| Mortality of female life | PFA92C20 |
| Expenses | Nil |
- [4]

- 4** A gymnasium offers membership for a three-year period at a fixed fee of £240 per annum payable monthly in advance. The contract may only be cancelled at a renewal anniversary. Monthly premiums cease immediately on the death of the member.
- Calculate the expected present value of membership fees if the gymnasium sells 120 memberships:
- Basis:
- | | |
|------------------------|-------------------------|
| Rate of interest | 6% per annum |
| Rate of mortality | 1% per annum |
| Probability of renewal | 80% at each anniversary |
| Expenses | Nil |
- [5]

- 5** A pension scheme provides an age retirement benefit of $n/80$ ths of final pensionable salary where n is total number of years of service. Final pensionable salary is the average salary in the three years before retirement. Normal retirement age is 65 and age retirement is only permitted between ages 60 and 65 exact.

A member of the pension scheme currently aged 45 exact has 12 years of service and their salary in the year before the valuation date was £25,000.

Give a formula for the expected cashflows between the 66th and 67th birthdays as a result of entitlement from this past service. [5]

- 6** Calculate:

(a) $\bar{A}_{30:40}$

(b) $\bar{a}_{30:40:20|}$

Basis:

$\mu = 0.01$ throughout for the life aged 30 now

$\mu = 0.02$ throughout for the life aged 40 now

$\delta = 4\%$ per annum

[6]

- 7** A life insurance company issues a 10-year term assurance policy to a life aged 55 exact. The sum assured which is payable immediately on death is given by the formula:

$$50,000 \times (1 + 0.1t) \quad t = 0, 1, 2, \dots, 9$$

where t denotes the curtate duration in years since the inception of the policy.

Level premiums are payable monthly in advance throughout the term of the policy or until earlier death.

Calculate the monthly premium for this policy using the following basis:

Mortality	AM92 Select
Interest	4% per annum
Expenses	Nil

[6]

- 8** Describe the causal factors that explain observed differences in mortality and morbidity. [6]

- 9** The actuary advising a pension scheme has decided that the independent mortality in the standard table for pension schemes (PEN) from page 142 of the Formulae and Tables for Actuarial Examinations is no longer appropriate for that pension scheme.

Calculate the revised row of the service table for age 61, assuming that the revised independent mortality rate at that age is 80% of the previous independent mortality rate.

[7]

- 10** Define the following terms, giving formulae and defining all notation used:

- (a) Crude mortality rate
- (b) Indirectly standardised mortality rate

[7]

- 11** A life insurance company issues a four-year unit-linked policy to a male life. The following non-unit cash flows, $NUCF_t$ ($t = 1, 2, 3, 4$), are obtained at the end of each year t per policy in force at the start of the year t :

Year t	1	2	3	4
$NUCF_t$	-50.2	-43.1	-32.1	145.5

Assume that the annual mortality rate for the male life is constant at 1% at all ages.

- (i) Show that the annual internal rate of return is 6%. [3]

The company sets up reserves in order to zeroise future negative cash flows. The rate of interest earned on non-unit reserves is 2.5% per annum.

- (ii) Calculate the net present value of the profits after zeroisation using a risk discount rate of 6% per annum. [3]

- (iii) Comment on the results obtained in (i) and (ii) above. [1]

[Total 7]

- 12** A life insurance company issued a with profits whole life policy to a life aged 40 exact on 1 January 2000. Under the policy, the basic sum assured of £50,000 and attaching bonuses are payable immediately on death. Level premiums are payable annually in advance under the policy until age 65 or earlier death.

The company declares simple reversionary bonuses at the start of each year including the first year and the bonus entitlement on the policy is earned immediately the bonus is declared.

- (i) Give an expression for the gross future loss random variable under the policy at the outset, defining symbols where necessary. [4]

- (ii) Calculate the annual premium using the following assumptions:

Mortality	AM92 Select
Interest	6% per annum
Bonus loading	2.5% per annum simple
Initial expenses	£300
Renewal expenses	£25 at the start of the second and subsequent policy years while the policy is in force
Claim expenses	£250

[4]

On 31 December 2009, the policy is still in force. Bonuses declared to date total £13,750.

- (iii) Calculate the gross premium prospective reserve for the policy as at 31 December 2009 using the following assumptions:

Mortality	AM92 Ultimate
Interest	4% per annum
Bonus loading	3% per annum simple
Renewal expenses	£35 at the start of each policy year while the policy is in force
Claim expenses	£250

[4]

[Total 12]

- 13** On 1 January 2009, a life insurance company issued 10,000 joint life whole life assurance policies to couples. Each couple comprised one male life aged 60 exact and one female life aged 55 exact when the policy commenced. Under each policy, a sum assured of £100,000 is payable immediately on the death of the second of the lives to die.

Premiums under each policy are payable annually in advance while at least one of the lives is alive.

The life insurance company uses the following basis for calculating premiums and net premium reserves:

Mortality	PMA92C20 for the male PFA92C20 for the female
Interest	4% per annum
Expenses	Nil

- (i) Calculate the annual premium payable under each policy. [4]

During the calendar year 2009, there was one claim for death benefit, in respect of a policy where both the male and the female life died during the year. In addition, there were 20 males and 10 females who died during the year.

- (ii) Calculate the mortality profit or loss for the group of 10,000 policies for the calendar year 2009. [10]
[Total 14]

- 14** A life insurance company issues four-year without profits endowment assurance policies to male lives aged 56 exact. The sum assured is £21,500 payable on maturity or at the end of the year of death if earlier. Premiums of £5,000 are payable annually in advance throughout the term of the policy.

The company holds net premium reserves for these policies, calculated using AM92 Ultimate mortality and interest of 4% per annum.

Surrenders occur only at the end of a year immediately before a premium is paid. The surrender value is 70% of the net premium reserve calculated at the time the surrender value is payable.

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

Rate of interest on cash flows	4% per annum
Mortality	AM92 Select
Surrenders	10% of all policies still in force at the end of each of the first, second and third policy years
Initial expenses	£600
Renewal expenses	£45 per annum on the second and subsequent premium dates
Risk discount rate	6% per annum

Calculate the expected profit margin for this contract. [15]

END OF PAPER