INSTITUTE AND FACULTY OF ACTUARIES

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EXAMINATION

Spare September 2018

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. *You have 15 minutes of planning and reading time before the start of this examination. You may make separate notes or write on the exam paper but not in your answer booklet. Calculators are not to be used during the reading time. You will then have three hours to complete the paper.*

4. *Mark allocations are shown in brackets.*

5. *Attempt all 13 questions, beginning your answer to each question on a new page.*

6. *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) $_{10|5}q_{49}$

(b) $e_{[43]:\overline{25|}}$

(c) $A^{1}_{40:\overline{15|}}$

Basis:

Mortality   AM92
Rate of Interest   4% per annum

[3]

2 A life insurance company issues a whole of life assurance policy to a life aged x with a sum assured S payable at the end of the year of death. Annual premiums at rate P are payable annually in advance throughout life.

The company assumes the following basis to calculate P for this policy:

Initial expenses I

Renewal expenses   100e% of the second and subsequent annual premiums

Claims expenses   100f% of the sum assured

Write down equations linking the gross premium reserves at the end of successive years.

[4]

3 Calculate $A_{\overline{40:50}}$

Basis:

Force of mortality = 0.02 throughout for the life aged 40 now
Force of mortality = 0.03 throughout for the life aged 50 now
Rate of Interest   4% per annum

[4]

4   A special joint whole of life policy provides, in return for a single premium, a lump sum benefit payable immediately on the first death of two lives currently aged 65 exact. The lump sum is 100,000 if death occurs within the first ten years reducing to 50,000 thereafter. At the tenth anniversary if both lives have survived 50% of the premium is payable.

Calculate the single premium payable.

Basis:

Mortality   PMA92C20 (First life) PFA92C20 (Second life)
Rate of Interest   4% per annum
Expenses   Ignore

[5]

5   A life insurance company writes term assurance policies that provide a lump sum on death or on earlier diagnosis of critical illness. The policies are funded by regular premiums that are suspended if the policyholder is diagnosed as suffering from ill-health. If the ill-health becomes critical then the lump sum is paid and the policy terminates.

Draw a transition state model for these policies, labelling clearly.

[5]

6   (i)   Describe the five most important classes of lives in a pension fund.   [5]

(ii)   Give two examples of selection exhibited by these classes of lives.   [2]
[Total 7]

7   A life aged 45 exact purchases a 3-year assurance policy with a sum assured of 50,000 payable if death occurs in the first policy year, 75,000 payable if death occurs in the second policy year and 100,000 payable if death occurs in the third policy year. The death benefit is payable at the end of the policy year of death. On survival to the end of the term of the policy, a benefit is payable equal to the total premiums paid.

Level premiums of 5,000 are payable annually in advance throughout the term of the policy or until earlier death.

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

Basis:

Mortality	AM92 Select
Interest earned on cash flows	3% per annum
Initial expenses	165
Renewal expenses	2.5% of the annual premium incurred at the start of both the second and third policy years
Risk discount rate	4% per annum

Assume no additional reserves are required for this policy.

[7]

8   A life insurance company has a portfolio of whole of life assurance policies. Premiums on these policies are payable annually in advance and the benefits are payable at the end of the year of death.

You are given the following information relating to a group of policies within the portfolio of whole of life assurance policies:

Age exact on 1 January 2017	Total sum assured in force on 1 January 2017	Reserves held on 31 December 2017 for policies in force at that date
57	1,567,000	576,000

During 2017, there were 2 death claims as follows:

- One claim on a policy which was issued on 1 January 2003 for a sum assured of 25,000.
- The second claim on a policy which was issued on 1 January 1997 for a sum assured of 10,000.

Calculate the mortality profit or loss for 2017 to the company in respect of this group of policies assuming net premium reserves are held on the following basis:

Mortality	AM92 Ultimate
Rate of Interest	4% per annum

[7]

9 The data below is shown in respect of the population of a country and two of its regions:

	Country		Region A		Region B	
Age	Population	Number of deaths	Population	Number of deaths	Population	Number of deaths
0–19	800,000	450	54,000	30	75,000	30
20–39	650,000	626	42,000	45	60,000	65
40–59	567,000	1,201	40,000	65	45,000	65
60+	400,000	9,563	52,000	1,200	32,000	653

(i) Calculate for both Regions, using where relevant the Country as the standard population:

(a) Crude death rates;

(b) Directly standardised mortality rates;

(c) Standardised mortality ratios.

[6]

(ii) Comment on your answers to part (i). [2]

[Total 8]

10 A company provides the following benefits to one of its employees currently aged 63 exact:

- On retirement at age 65 a pension of 10,000 payable annually in advance for the whole of life.
- On ill-health retirement before age 65 a pension of 5,000 payable annually in advance for ten years certain after which payments cease.
- On death in service a lump sum of 50,000 payable immediately.

Calculate the expected present value of the benefits, assuming a constant force of mortality and ill health retirement across each year of age before age 65.

Basis:

Mortality	PMA92C20
Ill-health retirement	Independent rate of 5% per annum
Withdrawals	Ignore
Rate of Interest	4% per annum

[9]

11 A life insurance company issues an annuity policy where the annuity is payable monthly in advance in respect of a male life currently aged 65 exact and a female life currently aged 60 exact. Payments commence on the first death and continue until the death of the surviving life. On the second death a lump sum funeral benefit of 2,000 is payable immediately.

Calculate the annuity provided for a single premium of 10,000.

Basis:

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

[9]

12 A life insurance company issues a two-year unit-linked endowment assurance policy to a male life currently aged 55 exact.

If the policyholder dies during the term of the policy, a death benefit of 125% of the bid value of the units is payable at the end of the policy year of death.

The policyholder may only surrender the policy at the end of the first policy year. On surrender, the bid value of units less a surrender value penalty of 750 is payable.

On maturity, 100% of the bid value of the units is payable.

Level premiums of 3,500 per annum are payable annually in advance throughout the term of the policy or until earlier death with 97.5% of each premium being allocated to units. A policy fee of 60 is deducted from the bid value of units at the start of each policy year. The units are subject to a bid-offer spread of 5%.

An annual management charge of 1% 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, surrender and maturity benefits are paid.

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

Rate of growth on assets in the unit fund	4% per annum in year 1
	3.5% per annum in year 2
Rate of interest on non-unit fund cash flows	2.5% per annum
Mortality	AM92 Select
Surrenders	5% of all policies in force at the end of policy year 1
Initial expense	235
Renewal expense	75 on the second premium date
Initial commission	5% of first premium
Renewal commission	2.5% of the second premium
Death claim expense	100
Maturity claim expense	60
Risk discount rate	5% per annum

(i)   Calculate the non-unit fund cash flows in the first year of the policy if the policyholder:

     (a)   dies in the first year of the contract.

     (b)   surrenders in the first year of the contract.

     (c)   dies in the second year of the contract.

     (d)   survives to the end of the contract.

[9]

(ii)   Calculate the non-unit fund cash flows in the second year of the policy if the policyholder:

     (a)   dies in the second year of the contract.

     (b)   survives to the end of the contract.

[2]

(iii)   Calculate the expected present value of profit of the policy.   [5]

[Total 16]

13 A life insurance company issues a 3-year term assurance policy to a life currently aged 62 exact for a sum assured of 250,000 payable at the end of year of death.

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

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

Rate of interest on cash flows	4% per annum
Mortality	AM92 Select
Initial expenses	315
Renewal expenses	55 per annum on the second and third premium dates
Initial commission	12.5% of first premium
Renewal commission	2.5% of the second and third years' premiums
Risk discount rate	4% per annum
Reserves	Ignore

(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) Explain without further calculation the effect of setting up reserves within the calculation of part (iii). [1]

[Total 16]

END OF PAPER