Queen Mary
University of London

Main Examination period 2019

MTH5125: Actuarial Mathematics II

Duration: 2 hours

Apart from this page, you are not permitted to read the contents of this question paper until instructed to do so by an invigilator.

You should attempt ALL questions. Marks available are shown next to the questions.

Only non-programmable calculators that have been approved from the college list of non-programmable calculators are permitted in this examination. Please state on your answer book the name and type of machine used.

Complete all rough work in the answer book and cross through any work that is not to be assessed.

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Examiners: C. Sutton, A. Baule

 Turn Over

Question 1. [21 marks] Consider a whole life assurance for a life age 38 with a sum assured of £60,000 payable at the end of year of death secured by level annual premiums paid at the beginning of each policy year. The life assurance company assumes initial expenses of £2000, renewal expenses of 3% of each premium and termination expenses of £100.

(a) Write down the equation of value for this policy. [**4**]

(b) Calculate the annual premium if $A_{38} = 0.255$ and the interest rate is 4% p.a. [**5**]

(c) Write down the equation for the gross future loss variable for this policy. [**2**]

(d) What is the smallest annual premium that leads to the probability of the life assurance company making a loss being less than 5% if mortality follows the life table below and interest is 4% p.a.? [**10**]

Age x	38	39	40	41	42	43	44	45	46	47
l_x	9420	9398	9337	9252	9188	9116	9047	8980	8915	8844

Question 2. [21 marks] A life assurance company offers a policy to two lives both age 40 which pays a sum assured of £50,000 at the end of the policy year following the second death for which annual premiums are only payable whilst both policyholders are alive. The company assumes initial expenses of £1,000 plus renewal expenses of 2.5% of each premium, and uses an interest rate of 3% p.a.

(a) Calculate the gross premium using the equivalence principle and the whole life assurance values from the table below. [**10**]

x	A_x	$A_{x:x}$
40	0.272	0.505
45	0.324	0.549
50	0.383	0.592

(b) Calculate the prospective gross premium reserve after 10 years on the same basis as (a) above assuming both lives are still alive at the time. [**7**]

(c) How would the reserve calculation need to change if one of the lives had died in the first 10 years of the policy? [**4**]

Question 3. [**15 marks**] Consider two lives, X age 60 and Y age 65.

(a) Calculate the present value of a joint life annuity of £100 per annum payable continuously assuming 2% interest and constant forces of mortality of 0.03 for X and 0.04 for Y. [**8**]

(b) What amount of reversionary annuity per annum payable to X with Y as the counter-life has an expected present value of £20,000 on the same basis as that used in (a) above? [**7**]

Question 4. [**14 marks**] A mobile phone company offers a one-year insurance policy which will pay for the cost of repairs to broken phones, will replace phones which cannot be repaired and will pay a cash benefit if a policyholders phone is stolen.

(a) Draw a multiple state model that could be used to value these benefits, clearly labelling and defining all states and transition intensities. [**9**]

(b) Give a formula for the probability that a mobile phone remains working throughout the year in terms of the transition intensities used in (a) above. [**5**]

Question 5. [19 marks] An insurance policy which offers both life assurance and critical illness cover for a fixed term of three years is sold to a life age 40 at outset. The policy pays £40,000 immediately on death during the term. If the policyholder is diagnosed with a critical illness whilst the policy is in-force an immediate payment of £70,000 is made. Once the critical illness benefit has been paid the life assurance element is no longer payable. The forces of decrement due to death μ_x^d and critical illness μ_x^c are given in the table below.

Age x	μ_x^d	μ_x^c
40	0.0022	0.0005
41	0.0024	0.0005
42	0.0027	0.0006

(a) Construct a multiple decrement table for ages 40, 41, 42 and 43 with a radix of 100,000 at age 40. [**12**]

(b) Use this multiple decrement table to find the present value of the two insurance benefits at outset assuming an interest rate of 3% p.a. [**7**]

Question 6. [10 marks]

(a) Define the following types of selection and in each case give an example that is relevant for actuaries calculating annuity rates : [**6**]

- time selection
- spurious selection
- adverse selection

(b) A life assurance company uses mortality rates from a life table based on a mortality investigation in 2010. If mortality rates are assumed to be reducing by 0.15% per annum, explain how those life table mortality rates obtained in 2010 might be adjusted for annuity values being calculated in 2019. [**4**]

End of Paper.