ACSC/STAT 4720, Life Contingencies II
Fall 2016
Toby Kenney
Homework Sheet 2
Due: Friday 5th October: 12:30 PM

Basic Questions

1. The following is a standard multiple decrement table giving probabilities of death and surrender for a life insurance policy:

x	l_x	$d_x^{(1)}$	$d_x^{(2)}$
53	10000.00	39.60	1.62
54	9958.78	39.43	1.74
55	9917.61	39.26	1.86
56	9876.49	39.09	2.00
57	9835.40	38.91	2.15

A life who is in poor health has the following lifetable.

x	l_x	d_x
53	10000.00	9.10
54	9990.90	9.90
55	9980.99	10.77
56	9970.22	11.72
57	9958.50	12.75

Use this lifetable and the standard multiple decrement table to produce a multiple decrement table for this life, assuming that this life has standard surrender probabilities, using:

(a) UDD in the multiple decrement table.

(b) UDD in the independent decrements.

2. The mortalities for a husband and wife (whose lives are assumed to be independent) aged 34 and 51 respectively, are given in the following tables:

x	l_x	d_x		x	l_x	d_x
34	10000.00	2.50		51	10000.00	7.70
35	9997.50	2.74		52	9992.30	8.37
36	9994.76	3.01		53	9983.93	9.11
37	9991.75	3.30		54	9974.82	9.91
38	9988.45	3.62		55	9964.91	10.78
39	9984.83	3.98		56	9954.14	11.72
40	9980.85	4.37		57	9942.42	12.74
41	9976.48	4.80		58	9929.67	13.86
42	9971.69	5.26		59	9915.81	15.07
43	9966.42	5.78		60	9900.75	16.38

The interest rate is $i = 0.07$.

(a) They want to purchase a 10-year joint life insurance policy with a death benefit of $400,000. Annual premiums are payable while both are alive. Calculate the net premium for this policy using the equivalence principle.

(b) They want to purchase a 10-year reversionary annuity, which will provide an annuity to the husband of $40,000 at the start of each year if the husband is alive and the wife is dead, provided the wife dies within the first 10 years. Calculate the net premium for this policy using the equivalence principle. For the husband, $\ddot{a}_{44} = 13.96$.

3. A husband is 80; the wife is 67. Their lifetables while both are alive, and the lifetable for the wife if the husband is dead, are given below:

x	l_x	d_x	x	l_x	d_x	x	l_x	d_x
80	10000.00	589.06	67	10000.00	117.26	67	10000.00	217.43
81	9410.94	609.24	68	9882.74	126.08	68	9782.57	233.54
82	8801.70	626.21	69	9756.65	135.43	69	9549.03	250.30
83	8175.50	639.23	70	9621.23	145.30	70	9298.73	267.63
84	7536.26	647.59	71	9475.93	155.69	71	9031.10	285.39
85	6888.68	650.54	72	9320.24	166.61	72	8745.70	303.46
86	6238.14	647.43	73	9153.64	178.03	73	8442.24	321.63
87	5590.71	637.67	74	8975.61	189.92	74	8120.61	339.70
88	4953.04	620.87	75	8785.69	202.26	75	7780.91	357.38
89	4332.17	596.80	76	8583.43	214.99	76	7423.53	374.38

Calculate the annual premium for a 10-year term insurance policy sold to the wife with death benefit $500,000. The interest rate is $i = 0.03$. Use the UDD assumption for handling changes to the wife's mortality in the event of the husband's death.

Standard Questions

4. The following is a multiple decrement table giving probabilities of death and surrender for a life insurance policy:

x	l_x	$d_x^{(1)}$	$d_x^{(2)}$
53	10000.00	39.60	1.62
54	9958.78	39.43	1.74
55	9917.61	39.26	1.86
56	9876.49	39.09	2.00
57	9835.40	38.91	2.15
58	9794.34	38.74	2.31
59	9753.28	38.57	2.49
60	9712.22	38.39	2.69
61	9671.15	38.21	2.90
62	9630.03	38.02	3.14

A life insurance policy has a death benefit of $300,000 payable at the end of the year of death. Premiums are payable at the beginning of each year. Surrenders receive a payment equal to half the policy value (policy values are calculated under the assumption that there are no surrenders). Calculate the premium for a 10-year policy sold to a life aged 53 if the interest rate is $i = 0.06$.

5. A couple want to receive the following:

   - While both are alive, they would like to receive a pension of $60,000 per year.
   - If the husband is alive and the wife is not, they would like to receive a pension of $80,000 per year.
   - If the wife is alive and the husband is not, they would like to receive a pension of $50,000 per year.
   - When the wife dies: if the husband is still alive, they would like a death benefit of $130,000; otherwise, they would like a death benefit of $85,000.

   Construct a combination of insurance and annuity policies that achieve this combination of benefits.

6. A husband aged 53 and wife aged 56 have the following transition intensities:

$$\mu_{xy}^{01} = 0.0001y + 0.0004$$
$$\mu_{xy}^{02} = 0.0002x - 0.0006$$
$$\mu_{xy}^{03} = 0.0005$$
$$\mu_{x}^{13} = 0.0004x + 0.0008$$
$$\mu_{y}^{23} = 0.0002y - 0.0002$$

   They want to purchase a last survivor insurance, which will pay a death benefit of $700,000 as soon as they are both dead. Premiums are payable continuously while either is alive. Force of interest is $\delta = 0.05$.

   (a) Calculate the annual rate of continuous premium.

   (b) Calculate the policy value after 5 years if the husband is dead and the wife is alive.