

ACSC/STAT 4720, Life Contingencies II

Fall 2017

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Homework Sheet 2

Due: Friday 6th October: 12:30 PM

**Basic Questions**

- 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	169.90
54	9830.10	189.00
55	9641.10	209.78
56	9431.32	232.25
57	9199.07	256.38

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:

- UDD in the multiple decrement table.
  - UDD in the independent decrements.
- The mortalities for a husband and wife (whose lives are assumed to be independent) aged 42 and 33 respectively, are given in the following tables:

$x$	$l_x$	$d_x$
42	10000.00	14.27
43	9985.73	15.66
44	9970.08	17.18
45	9952.90	18.86
46	9934.04	20.70
47	9913.34	22.72
48	9890.62	24.93
49	9865.69	27.37
50	9838.32	30.03
51	9808.29	32.95

$x$	$l_x$	$d_x$
33	10000.00	5.53
34	9994.47	6.04
35	9988.43	6.60
36	9981.83	7.22
37	9974.61	7.90
38	9966.71	8.65
39	9958.06	9.47
40	9948.59	10.37
41	9938.22	11.37
42	9926.85	12.46

The interest rate is  $i = 0.04$ .

- (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 last survivor insurance with a benefit of \$8,000,000. Premiums are payable while either life is alive. Calculate the net premium for this policy using the equivalence principle.
3. A husband is 75; the wife is 88. Their lifetables while both are alive, and the lifetable for the husband if the wife is dead, are given below:

$x$	$l_x$	$d_x$	$x$	$l_x$	$d_x$	$x$	$l_x$	$d_x$
75	10000.00	185.40	88	10000.00	250.56	75	10000.00	280.55
76	9814.60	205.34	89	9749.44	273.99	76	9719.45	307.75
77	9609.26	226.87	90	9475.44	298.68	77	9411.70	336.35
78	9382.39	249.99	91	9176.76	324.47	78	9075.35	366.07
79	9132.39	274.63	92	8852.29	351.09	79	8709.27	396.53
80	8857.77	300.63	93	8501.20	378.22	80	8312.74	427.22
81	8557.13	327.81	94	8122.98	405.40	81	7885.52	457.45
82	8229.33	355.83	95	7717.58	432.08	82	7428.07	486.43
83	7873.50	384.28	96	7285.50	457.58	83	6941.64	513.14
84	7489.22	412.59	97	6827.93	481.09	84	6428.50	536.44

Calculate the probability that the husband is alive in 10 years time. Use the UDD assumption for handling changes to the husband's mortality in the year of the wife's death.

## Standard Questions

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

$x$	$l_x$	$d_x^{(1)}$	$d_x^{(2)}$
44	10000.00	1.03	1.37
45	9997.60	1.04	1.55
46	9995.01	1.06	1.74
47	9992.21	1.08	1.96
48	9989.17	1.09	2.23
49	9985.85	1.11	2.51
50	9982.23	1.13	2.83
51	9978.27	1.16	3.18
52	9973.93	1.18	3.59
53	9969.16	1.21	4.04

A life insurance policy pays a benefit of \$300,000 at the end of the year of death, with an increased benefit of \$700,000 for accidental death. Premiums are payable at the beginning of each year. Calculate the premium for a 10-year policy sold to a life aged 44 if the interest rate is  $i = 0.03$ .

5. A couple want to receive the following:

- While both are alive, they would like to receive a pension of \$90,000 per year.

- If the husband is alive and the wife is not, they would like to receive a pension of \$130,000 per year.
- If the wife is alive and the husband is not, they would like to receive a pension of \$70,000 per year.
- When the husband dies: if the wife is still alive, they would like a death benefit of \$30,000; otherwise, they would like a death benefit of \$80,000.
- When the wife dies: if the husband is still alive, they would like a death benefit of \$60,000; otherwise, they would like a death benefit of \$120,000.

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

6. A husband aged 63 and wife aged 59 have the following transition intensities:

$$\mu_{xy}^{01} = 0.0002y + 0.0003$$

$$\mu_{xy}^{02} = 0.0002x - 0.0005$$

$$\mu_{xy}^{03} = 0.0008$$

$$\mu_x^{13} = 0.0003x + 0.0008$$

$$\mu_y^{23} = 0.0002y + 0.0004$$

They want to purchase a reversionary annuity, which will pay a continuous annuity of \$70,000 per year to the wife if the husband is dead. Premiums are payable continuously while both are alive. Force of interest is  $\delta = 0.04$ .

- Calculate the annual rate of continuous premium.
- Calculate the policy value after 5 years if the husband is dead and the wife is alive.