

ACSC/STAT 3720, Life Contingencies I  
Winter 2017  
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Homework Sheet 7  
Due: Friday 31st March: 12:30 PM

## Basic Questions

1. An insurance company sells 600 whole life insurance policies with annual net premiums to lives aged 38. The death benefit on these policies is \$400,000. The interest rate is  $i = 0.06$ . In the first year of the policies:

- No policyholders die.
- The company earns interest  $i = 0.05$ .

The company still uses  $i = 0.06$  as its basis for calculating the policy values. What is the company's annual profit on these policies? [Using the lifetable in Table 1, we have  $A_{38} = 0.0580484$  and  $A_{39} = 0.0611489$ .]

2. An insurance company sells 700 25-year term insurance policies to lives aged 45. The death benefit of these policies is \$800,000. The interest rate is  $i = 0.045$  and net premiums are payable annually in advance. At this interest rate,  $A_{45} = 0.142031$  and  $A_{70} = 0.359627$ . In the first two years of the policy:

- two policyholders die in the first year of the policy.
- The company earns interest  $i = 0.06$  in the first year of the policy, and  $i = 0.05$  in the second year.

Calculate the asset share of the remaining policies after the second year.

3. A life aged 37 purchases a whole-life insurance policy with a death benefit of \$600,000. The interest rate is  $i = 0.05$ . From the lifetable in Table 1, we have  $A_{37} = 0.0827855$  and  $A_{44} = 0.112997$ . Using Woolhouse's formula, this results in a monthly premium of \$225.15.

(a) calculate the policy value after 6 years and 9 months. [You may use the UDD assumption for the distribution of deaths in Year 7, but use Woolhouse's formula to calculate  $\ddot{a}_{44}^{(12)}$ .]

(b) calculate the policy value after 6 years 8.2 months.

## Standard Questions

4. An insurance company wants to design a 10-year term policy with continuous premiums so that the policy value is given by  ${}_tV = 150t(t - 10)(t - 15)$ . The death benefits at time  $t$  are  $100000(3 + 0.1t)$ . The policy is sold to a life aged 36, with mortality given by  $\mu_x = 0.0000045(1.12)^x$ . Calculate the premiums as a function of time if force of interest is  $\delta = 0.051$ .

5. An insurance company is valuing its policies. It finds that the total value of a large group of 200 policies was \$16,000,000. The total annual premium for all these policies is \$1,800,000. The interest rate is  $i = 0.06$ . All of the policies have a mortality rate  $q_x = 0.07$ . There are three types of policy in the portfolio — 120 of the policies are type 1 and have death benefit \$900,000; 40 are type 2 and have death benefit \$1,500,000; and the remaining 40 are type 3 and have death benefit \$1,300,000. There are no expenses associated with the policies, and during the following year 6 type 1 policyholders die, 2 type 2 policyholders die and 2 type 3 policyholders die. What is the total value of all the remaining policies the following year?

Table 1: Select lifetable to be used for questions on this assignment

$x$	$l_{[x]}$	$l_{[x]+1}$	$l_{[x]+2}$	$l_{[x]+3}$	$x$	$l_{[x]}$	$l_{[x]+1}$	$l_{[x]+2}$	$l_{[x]+3}$
25	9998.75	9997.65	9996.30	9994.66	74	8987.73	8932.10	8862.49	8775.52
26	9997.00	9995.83	9994.40	9992.66	75	8897.04	8836.71	8761.27	8667.10
27	9995.14	9993.90	9992.38	9990.52	76	8798.69	8733.34	8651.66	8549.78
28	9993.16	9991.84	9990.22	9988.24	77	8692.13	8621.41	8533.09	8423.00
29	9991.05	9989.65	9987.92	9985.80	78	8576.81	8500.36	8404.95	8286.16
30	9988.81	9987.30	9985.46	9983.18	79	8452.13	8369.60	8266.68	8138.66
31	9986.40	9984.80	9982.82	9980.38	80	8317.52	8228.53	8117.67	7979.93
32	9983.83	9982.11	9979.99	9977.37	81	8172.36	8076.57	7957.35	7809.41
33	9981.07	9979.23	9976.95	9974.13	82	8016.08	7913.13	7785.15	7626.56
34	9978.11	9976.13	9973.68	9970.64	83	7848.11	7737.67	7600.54	7430.89
35	9974.93	9972.79	9970.16	9966.88	84	7667.89	7549.66	7403.05	7221.99
36	9971.50	9969.20	9966.36	9962.82	85	7474.92	7348.64	7192.27	6999.51
37	9967.80	9965.33	9962.25	9958.44	86	7268.77	7134.21	6967.86	6763.22
38	9963.81	9961.14	9957.82	9953.69	87	7049.07	6906.07	6729.62	6513.04
39	9959.50	9956.61	9953.02	9948.55	88	6815.55	6664.05	6477.46	6249.02
40	9954.84	9951.71	9947.82	9942.98	89	6568.09	6408.10	6211.48	5971.42
41	9949.79	9946.41	9942.19	9936.94	90	6306.70	6138.35	5931.96	5680.73
42	9944.32	9940.66	9936.08	9930.38	91	6031.59	5855.15	5639.41	5377.67
43	9938.39	9934.41	9929.45	9923.26	92	5743.19	5559.08	5334.61	5063.27
44	9931.96	9927.64	9922.25	9915.52	93	5442.15	5250.97	5018.61	4738.86
45	9924.97	9920.28	9914.42	9907.10	94	5129.44	4931.97	4692.79	4406.12
46	9917.37	9912.28	9905.91	9897.94	95	4806.33	4603.54	4358.89	4067.08
47	9909.11	9903.58	9896.65	9887.98	96	4474.39	4267.51	4018.96	3724.10
48	9900.13	9894.11	9886.57	9877.13	97	4135.60	3926.04	3675.44	3379.91
49	9890.36	9883.80	9875.59	9865.30	98	3792.25	3581.66	3331.11	3037.57
50	9879.71	9872.57	9863.63	9852.42	99	3447.02	3237.23	2989.05	2700.39
51	9868.12	9860.34	9850.59	9838.38	100	3102.90	2895.94	2652.63	2371.88
52	9855.48	9847.01	9836.39	9823.08	101	2763.19	2561.21	2325.37	2055.64
53	9841.72	9832.48	9820.90	9806.39	102	2431.39	2236.61	2010.90	1755.27
54	9826.71	9816.64	9804.02	9788.18	103	2111.15	1925.80	1712.81	1474.18
55	9810.34	9799.37	9785.60	9768.33	104	1806.12	1632.34	1434.48	1215.44
56	9792.49	9780.52	9765.51	9746.67	105	1519.82	1359.55	1178.94	981.65
57	9773.03	9759.97	9743.60	9723.05	106	1255.46	1110.36	948.70	774.71
58	9751.79	9737.56	9719.69	9697.28	107	1015.81	887.14	745.58	595.71
59	9728.63	9713.10	9693.62	9669.17	108	802.96	691.49	570.56	444.87
60	9703.36	9686.43	9665.17	9638.51	109	618.23	524.17	423.71	321.41
61	9675.80	9657.33	9634.15	9605.07	110	462.04	385.00	304.13	223.65
62	9645.73	9625.59	9600.31	9568.61	111	333.80	272.80	210.00	149.10
63	9612.94	9590.98	9563.42	9528.85	112	231.99	185.53	138.71	94.62
64	9577.18	9553.24	9523.19	9485.52	113	154.19	120.34	87.07	56.74
65	9538.19	9512.09	9479.35	9438.30	114	97.30	73.90	51.50	31.84
66	9495.69	9467.25	9431.58	9386.86	115	57.78	42.55	28.41	16.52
67	9449.37	9418.39	9379.54	9330.85	116	31.92	22.69	14.43	7.81
68	9398.90	9365.17	9322.87	9269.88	117	16.15	11.04	6.63	3.30
69	9343.95	9307.23	9261.20	9203.55	118	7.34	4.79	2.69	1.21
70	9284.12	9244.18	9194.11	9131.43	119	2.90	1.79	0.93	0.37
71	9219.03	9175.59	9121.17	9053.07	120	0.95	0.55	0.26	0.09
72	9148.24	9101.03	9041.91	8967.97	121	0.23	0.13	0.05	0.01
73	9071.30	9020.03	8955.85	8875.63	122	0.03	0.02	0.01	0.00