

# ACSC/STAT 4720, Life Contingencies II

Fall 2015

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Homework Sheet 6

Due: Friday 2nd October: 12:30 PM

## Basic Questions

1. A policyholder aged 54 buys a 10-year type B universal life insurance policy. The additional death benefit is \$150,000. The policyholder pays a premium of \$4,200 at the start of each year. The lifetable for the policyholder is:

$x$	$l_x$	$d_x$
54	10000.00	8.33
55	9991.67	8.90
56	9982.77	9.54
57	9973.23	10.24
58	9962.99	11.01
59	9951.99	11.85
60	9940.14	12.78
61	9927.36	13.80
62	9913.56	14.91
63	9898.65	16.14

The cost of insurance is based on 105% of mortality in the above table and  $i = 0.03$ . Expense charges are 2% of the account value (after each premium is paid). Assume the credited interest rate is  $i = 0.05$ .

(a) Calculate the projected account value for the next 10 years.

(b) Suppose the insurer earns an interest rate,  $i = 0.04$ , and mortality follows the above table, initial expenses are \$700 and renewal expenses are 0.5% of account value each year after the first. Suppose there are no surrenders. Calculate the profit margin of this policy at a risk discount rate of  $i = 0.12$ .

2. A life aged 42 buys a 10-year type A universal life insurance policy with death benefit \$350,000. The annual premium is \$5,900. Mortality is as shown in the following table:

$x$	$l_x$	$d_x$
42	10000.00	7.60
43	9992.40	7.87
44	9984.54	8.17
45	9976.37	8.51
46	9967.86	8.89
47	9958.97	9.31
48	9949.66	9.79
49	9939.87	10.32
50	9929.56	10.91
51	9918.65	11.58

The credited interest rate is  $i = 0.06$ . Cost of insurance is based on mortality in the above table and  $i = 0.04$ . Expense charges are 2% of account value.

(a) Project the account value for the next 10 years.

(b) Assume that the insurance company earns interest  $i = 0.075$ ; Mortality is 105% of the mortality in the lifetable. Initial expenses are \$3,750; renewal expenses are 2% of premiums paid. The surrender charges and surrender rates are:

Year	Charge	rate
1	\$4,200	4%
2	\$3,500	5%
3	\$3,200	4%
4	\$2,800	3%
5	\$2,200	3%
6	\$1,400	4%
7	\$900	4%
8	\$400	5%
9	\$0	7%
10	\$0	100%

Which of the following is the internal rate of return of the policy:

(i)  $i = 0.0944$

(ii)  $i = 0.1218$

(iii)  $i = 0.1524$

(iv)  $i = 0.1760$

3. A life aged 39 has an annual type A Universal life insurance policy that has been in effect for 4 years.

- The current account value is \$32,418.
- The annual premium is \$6,300.
- The expense charge is 1.5% of account value.
- The credited interest rate is  $i = 0.04$ .
- The total death benefit is \$100,000.
- The corridor factor requirement is 2.6.
- The insurance is priced using mortality rate  $q_{39} = 0.000192$  and interest  $i = 0.03$ .

Calculate the cost of insurance charge for the year.

## Standard Questions

4. Consider an annual type B universal life insurance policy with annual premiums of \$3,000, additional death benefit \$80,000 with no corridor factor requirement. The expense charge is 1.5% of account value.

Surrender charges and rates are

Year	Charge	rate
1	\$2,200	4%
2	\$1,300	5%
3	\$800	4%
4	\$300	3%
5	\$0	100%

Initial expenses are \$800, and renewal expenses are \$30. Cost of insurance is based on mortality  $q_x = 0.000402$  and  $i = 0.04$ . The insurance company makes an annual rate of return equal to prime+1 (where the prime rate is set each year by the central bank). It offers credited interest as prime +  $a$  for some  $a$ . Calculate the value of  $a$  so that whatever the value of prime, the insurance company's profit margin on the policy at a risk discount rate of 10% is at least 5%. [Assume prime is always in the range 0–10%.]