

Chapters 6 – Past Test and Quiz Problems – Gross Premiums

****Note: For these problems to fit the 6-point question mold from Section 1 of your midterm/final, there could be a problem with non-level premium payments or death benefits, maybe monthly annuity payments rather than annual to test your understanding of the adjustment to a monthly annuity factor, etc.**

(4 points) Beau is (45) and buys a whole life policy with a death benefit of 70,000 paid at the end of the year of death. Gross premiums are paid annually.

You are given that mortality follows the Standard Ultimate Life Table with interest at 5%.

The expenses for Beau's policy are:

- i. Commissions of 60% of gross premium in the first year and 8% of gross premium in all years after the first;
- ii. Issue expense of 74.
- iii. Maintenance expense of 34 at the beginning of all years including the first year.
- iv. A claim expense of 750 paid at the end of the year of death.

(4 points) The gross premium based on the equivalence principle is 720 to the nearest 10. Calculate the gross premium based on 1.

Solution:

$$P\ddot{a}_{45} = 70,000A_{45} + 0.52P + 0.08P\ddot{a}_{45} + 74 + 34\ddot{a}_{45} + 750A_{45}$$

$$P = \frac{70,750A_{45} + 74 + 34\ddot{a}_{45}}{0.92a_{45} - 0.52} = \frac{(70,750)(0.15161) + 74 + (34)(17.8162)}{(0.92)(17.8162) - 0.52} = 718.68$$

(4 points) Amir is (55) and buys a whole life policy with a death benefit of 100,000 paid at the end of the year of death. Gross premiums are paid annually.

You are given that mortality follows the Standard Ultimate Life Table with interest at 5%.

The expenses for Amir's policy are:

- i. Commissions of 50% of gross premium in the first year and 12% of gross premium in all years after the first;
- ii. Issue Expense of 78;
- iii. Maintenance expense of 48 at the beginning of all years including the first year; and
- iv. A claim expense of 570 paid at the end of the year of death.

The gross premium based on the equivalence principle is 1780 to the nearest 10. Calculate the gross premium to the nearest 1.

Solution:

$$P\ddot{a}_{55} = 100,570A_{55} + 0.38P + 0.12P\ddot{a}_{55} + 78 + 48\ddot{a}_{55}$$

$$P = \frac{100,570A_{55} + 78 + 48\ddot{a}_{55}}{0.88a_{55} - 0.38} = \frac{24506.962}{13.752712} = 1,782$$

(4 points) The Lewis Life Insurance Company sells a whole life insurance policy to (75). The policy has a death benefit of 20,000 paid at the end of the year of death. The premiums are paid annually for the life of the policy.

You are given that mortality follows the Standard Ultimate Life Table with interest at 5%.

The policy has the following expenses. All expenses occur at the beginning of the policy year.

- Commissions of 50% of premium the first year and 8% of premiums in year 2 and later.
- Issue expenses of 500 per policy in the first year only.
- Maintenance expenses of 40 per policy in all years.
- Termination expense of 1000 per policy paid at the end of the year of death.

Calculate the annual gross premium using the equivalence principle.

Solution:

$$PVP = PVB + PVE$$

$$P\ddot{a}_{75} = 21,000A_{75} + 500 + 40\ddot{a}_{75} + 0.42P + 0.08P\ddot{a}_{75}$$

$$P = \frac{(21,000)(0.50868) + 500 + 40(10.3177)}{0.92(10.3178) - 0.42} = 1278.05$$

(4 points) Kaitlyn who is (70) buys a whole life insurance policy with a death benefit of 500,000 which is payable at the end of the year of death.

You are given that mortality follows the Standard Ultimate Life Table and $i = 0.05$.

The expenses associated with Kaitlyn's policy are:

- i. Commissions of 55% of premium in year 1 and 8% of premium thereafter;
- ii. Issue Expense of 300 per policy in the first year only;
- iii. Maintenance expenses of 40 per policy in all years including the first;
- iv. Termination expense of 1000 paid at the end of the year of death.

The gross premium based on the equivalence principle is 20,350 to the nearest 10. Calculate it to the nearest 0.01.

Solution:

$$PVP = PVB + PVE$$

$$P\ddot{a}_{70} = 500,000A_{70} + 0.47P + 0.08P\ddot{a}_{70} + 300 + 40\ddot{a}_{70} + 1000A_{70}$$

$$P = \frac{501,000A_{70} + 300 + 40\ddot{a}_{70}}{0.92\ddot{a}_{70} - 0.47} = \frac{(501,000)(0.42818) + 300 + 40(12.0083)}{0.92(12.0083) - 0.47} = 20,354.12$$

(5 points) The Pierce Life Insurance Company sells a 20 year term policy with a death benefit of 80,000 to (63). The death benefit is payable at the end of the year of death. The premiums for the policy are paid annually for 10 years.

You are given:

- i. Mortality follows the Standard Ultimate Life Table
- ii. $i = 0.05$
- iii. The expenses for the policy:
 1. 30% of premium the first year and 5% of premium thereafter. This expense stops when premiums stop.
 2. 100 per policy in the first year and 30 per policy in years 2 and later.

Calculate the gross premium for this policy if the gross premium is determined using the equivalence principle.

Solution:

$$PVP = PVB + PVE$$

$$P\ddot{a}_{63:\overline{10}|} = 80,000A_{63:\overline{20}|}^1 + 0.25P + 0.05P\ddot{a}_{63:\overline{10}|} + 70 + 30\ddot{a}_{63:\overline{20}|}$$

$$P = \frac{80,000A_{63:\overline{20}|}^1 + 70 + 30\ddot{a}_{63:\overline{20}|}}{0.95\ddot{a}_{63:\overline{10}|} - 0.25}$$

$$= \frac{80,000(0.42298 - 0.26674) + 70 + 30(12.1174)}{0.95(7.8960) - 0.25} = 1783.53$$