1. A 20 year endowment insurance of 1000 on (60) has level annual benefit premiums payable at the beginning of each year for 10 years. The death benefit is payable at the moment of death.

   You are given that mortality follows the Illustrative Life Table with $i = 0.06$ and that deaths are uniformly distributed between integral ages.

   Calculate the annual net premium.

2. A fully discrete whole life policy on (25) provides a death benefit of 1 million until age 65 and a death benefit of 0.5 million after age 65.

   You are given that mortality follows the Illustrative Life table with $i = 6\%$.

   Level annual net premiums are payable until age 65 at which time premiums stop.

   Calculate the level annual net premiums.

3. A special fully discrete whole life insurance is issued to (80). The special whole life has a death benefit of 1000.

   The annual net premiums for this whole life are level for the first 10 years. The annual net premiums after 10 years are also level but the annual net premium after the tenth year is twice the annual net premium during the first ten years.

   You are given that mortality follows the Illustrative Life Table and $i = 0.06$.

   Calculate the annual benefit premium after 10 years.

4. A fully discrete 20 year term insurance on (70) provides a death benefit of 100,000 for the first 10 years and a death benefit of 50,000 during the last 10 years.

   Annual net premiums are payable for 20 years. The annual net premium for the first five years is 5000. The annual net premium for the last 15 years is equal to π.

   You are given that mortality follows the Illustrative Life Table with $i = 0.06$.

   Calculate π.

5. A special fully discrete 3 year endowment insurance on (76) has an annual net premium of π that is payable for **two** years. The death benefit is 40,000 plus the sum of the premiums paid at the end of the year of death. At the end of three years, the policy endows for 40,000 plus the sum of the premiums paid. (Note that this means the death benefit in the first year is 40,000 + π and that the death benefit in the second and third year as well as the endowment benefit is 40,000 + 2π.)

   You are given that mortality follows the table immediately below and $v = 0.90$.

x	l_x
75	2000
76	1600
77	960
78	480
79	120
80	0

   Calculate π.

6. Emily (25) purchases a special whole life insurance policy with increasing death benefits. The death benefit is 50,000 for the first 10 years. It doubles at the end of 10 years to a death benefit of 100,000 if Emily dies between the end of the 10^{th} year and the end of the 20^{th} year. Finally, it doubles again at the end of the 20^{th} year so the death benefit is 200,000 if Emily dies after the end of the 20^{th} year.

   The death benefit is payable at the end of the year of death.

   The policy has annual net benefit premiums that are non-level and payable for life. The net benefit premiums is P for the first 20 years and then is $0.5P$ thereafter.

   You are given :
   a. Mortality follows the Illustrative Life Table.
   b. $i = 6\%$.

   Calculate P using the equivalence principle.

7. (Written Answer) Peterson Pet Insurance Company has developed the following life insurance table for dogs:

Age	l_x	Age	l_x
0	2000	5	1200
1	1950	6	1000
2	1850	7	700
3	1600	8	300
4	1400	9	0

Peterson sells a pet insurance policy on a dog who is age 5. The policy pays a death benefit at the end of the year of death of 1000. Level annual premiums are payable for the life of the dog.

The expenses associated with the policy are 10% of premium at the beginning of each year.

The interest rate used to calculate all values is 4%.

A. Calculate the gross premium for this insurance using the Equivalence Principle.

B. Calculate the loss that Petereson will incur if the dog dies in the second year if the gross premium is calculated using the Equivalence Principle.

C. Peterson decides to charge a gross premium so that the loss will be zero if the dog dies in the second year. Determine the gross premium that Peterson decides to charge.

D. Estimate the monthly premium equivalent to the annual premium in Part C. by using the two term Woolhouse formula.

8. Hassan, age 35, purchases a whole life policy with a death benefit of 1 million payable at the moment of death. He will pay level annual premiums during his lifetime.

   You are given:
   a. Mortality follows the Illustrative Life Table
   b. $i = 6\%$
   c. Death are uniformly distributed between integer ages.
   d. Expenses occurring at the beginning of the year are:
      i. First year expenses of 800 per policy and 2 per 1000 of death benefit.
      ii. Renewal expenses (occurring at the start of the second year and every year thereafter) are 60 per policy.
      iii. Commissions of 70% of premiums in the first year and 8% of premiums thereafter.
      iv. Premium Tax of 3% of premium.
   e. The company will incur a termination expense at the moment of death of 1000.

   Calculate the gross premium for this policy using the Equivalence Principle.

9. Rafidah purchases a fully continuous whole life insurance policy with a death benefit of 50,000 payable at the moment of death. Level net premiums are paid continuously for as long as Rafidah is alive.

   You are given:
   a. Rafidah is now age 50.
   b. Mortality follows the Illustrative Life Table
   c. $i = 6\%$
   d. Deaths are uniformly distributed between integer ages.

   Calculate the Variance for the loss random variable, L_0^n, for this policy.

10. You are given the following mortality table:

x	l_x
90	1000
91	900
92	700
93	400
94	100
95	0

For a whole life to (92) with a death benefit of 50,000 payable at the end of the year of death and level annual premiums, the expenses are 400 per policy at issue and 50 per policy at the beginning of each year including the first year.

You are given that $i = 5\%$.

a. Calculate the level gross premium using the equivalence principle.
b. Complete the following table:

K_x	L_0^g	Probability
0		
1		
2		

c. Calculate the variance of the loss at issue random variable.
d. Calculate the expected value and the variance of the loss at issue random variable if the gross premium was 30,000.

11. Chao (30) buys a 40-year endowment insurance with a death benefit of 40,000 from Li Life Insurance Company. The death benefit is payable at the end of the year of death.

You are given :

a. Mortality follows the Illustrative Life Table.
b. $i = 6\%$.
c. Deaths are uniformly distributed between integral ages.
d. The net annual benefit premium for this policy is 354.33.

A. Calculate the variance of the loss random variable L_0^n for this policy with annual premiums.

B. If the death benefit on the above policy was payable at the moment of death and the premiums were paid monthly, calculate what the monthly net benefit premium would be under the equivalence principle.

12. A fully discrete whole life insurance policy on (70) pays a death benefit of 100,000. The policy has annual net premiums determined by the equivalence principal.

You are given:

a. Mortality follows a 2 year select and ultimate mortality table such that
   i. $q_{[x]} = 0.5q_x$ where q_x is based on the Illustrative Life Table.
   ii. $q_{[x]+1} = 0.8q_{x+1}$ where q_{x+1} is based on the Illustrative Life Table.
   iii. Ultimate mortality follows the Illustrative Life Table
   iv. $i = 0.06$

Calculate the annual net premium.

13. You are given:

i. $\ddot{a}_{40} = 14$
ii. $\ddot{a}_{60} = 9$
iii. $\ddot{a}_{40:\overline{20}|} = 11.75$
iv. $i = 6\%$
v. Deaths is uniformly distributed between integral ages.

For a fully discrete 20 year term insurance on (40) with a death benefit of 56,000, the net premium is paid quarterly during the life of the policy.

Calculate quarterly net premium.

14. Surin purchases a fully discrete 2 year term insurance with a death benefit of 10,000. Surin is (80).

    You are given that:

    i. $q_{80} = 0.08$
    ii. $q_{81} = 0.12$
    iii. $v = 0.9$

    L_0^n is the loss-at-issue random variable based on the net premium.

    Calculate the $Var[L_0^n]$.

15. Matt who is (45) purchases a deferred annuity which will pay benefits beginning at age 65. The annuity will pay 10,000 at the beginning of each year if Matt is alive. If Matt dies during the deferral period, no benefits will be paid.

    Matt will pay annual net premiums for during the 20 year deferral period.

    You are given:

    i. Mortality follows the Illustrative Life Table
    ii. $i = 0.06$

    Calculate the annual net premium for this annuity.

16. Matt who is (45) purchases an annuity which will pay benefits beginning at age 65. The annuity will pay 10,000 at the beginning of each year with the first ten payments guaranteed. These first ten payments will be paid even if Matt dies before the payments begin. The payments after ten years will continue for as long Matt lives.

    Matt will pay annual net premiums for during the 20 year deferral period.

    You are given:

    i. Mortality follows the Illustrative Life Table
    ii. $i = 0.06$

    Calculate the annual net premium for this annuity.

17. Matt who is (45) purchases a deferred annuity which will pay benefits beginning at age 65. The annuity will pay 10,000 at the beginning of each year if Matt is alive. If Matt dies during the deferral period, his premiums plus interest will be paid as a death benefit but no annuity payments will be made

    Matt will pay annual net premiums for during the 20 year deferral period.

    You are given:

    i. Mortality follows the Illustrative Life Table
    ii. $i = 0.06$

    Calculate the annual net premium for this annuity.

18. You are given:

    i. $1000A_x = 600$
    ii. $i = 0.05$

    L_0^n is the loss-at-issue random variable for a fully discrete whole life of 10,000 on (x) based on the net premium.

    Calculate the value of L_0^n if death occurs during the 20^{th} year of the policy.

19. For a fully discrete whole life of 100 on (65), you are given:

    i. Maintenance expenses are 2.50 per policy at the start of each year
    ii. Issue expenses at the start of the first policy year of 1.
    iii. Mortality follows the Illustrative Life Table
    iv. $i = 6\%$

    The gross premium is determined using the equivalence principle.

    Calculate the variance of the loss-at-issue random variable.

20. For a special fully discrete 2-year endowment insurance on (80), you are given:

i. The death benefit 10,000.
ii. The endowment benefit is a return of the premiums paid without interest.
iii. Mortality follows the Illustrative Life Table.
iv. $i = 0.05$

Calculate the annual net premium.

Answers:

1. 58.66
2. 5190.45
3. 248.70
4. 4189.47
5. 128,090.41
6. 965.73
7.
    a. 390.81
    b. 234.63
    c. 523.71
    d. 53.15
8. 10,424.04
9. 157,062,748.5
10.
    a. 27,780.29
    b.

K_x	L_0^g	Probability
0	20,288.76	3/7
1	-8,388.62	3/7
2	-35,700.40	1/7

    c. 388,646,614
    d. -3715.33 and 448,058,325
11.
    a. 24,747,244
    b. 30.84
12. 5768.12
13. 103.40
14. 12,103.234
15. 2191.74
16. 4402.82
17. 2538.14
18. -7204.92
19. 1385
20. 4228.76