(New) Module 2 Section 6 Exercises (Part A):
(Variance of Insurance Present Value Random Variables)

Note: The insurance products described in these exercises are the same as in the Module 2 Section 4 Exercises. Since $E[Z_\sigma] = A_\sigma$ (i.e. EPV = APV), use your prior work in Section 4 to save time.

For each of the following insurances in Numbers 1 through 12, use ILT actuarial assumptions to determine

(a) an expression for the present value random variable Z, and
(b) the variance of the present value random variable, $Var(Z)$.

1. a whole life insurance of 5000, issued to a 35 year old, with the death benefit payable at the end of the year of death
2. a 10-year pure endowment of 350 issued to (40)
3. a 17-year pure endowment of 10000 issued to (35)
4. a discrete 17-year deferred whole life insurance of 500 issued to (35)
5. a discrete 2-year term life insurance of 750 issued to (32)
6. a 17-year term insurance of 2500 issued to (35), with benefit payable at the end of the year of death
7. a 1-year endowment insurance of 25,000 issued to (35), with death benefit payable at the end of the year of death
8. a 17-year endowment insurance of 8000 issued to (35), with death benefit payable at the end of the year of death
9. a discrete whole life insurance of 1000 issued to independent lives aged 30 and 40, with benefit payable upon the first death
10. a discrete whole life insurance of 1000 issued to independent lives aged 30 and 40, with benefit payable upon the first death if it occurs within the next 10 years
11. a discrete whole life insurance of 500 issued to independent lives aged 30 and 40, with benefit payable upon the last death
12. a discrete whole life insurance of 500 issued to independent lives aged 30 and 40, with benefit payable upon the last death if it occurs within the next 10 years

For Numbers 13 through 15, assume $i = .08$ and CF mortality with $\mu = -\ln(0.9)$.

13. Determine the variance of the present value random variable for a discrete whole life insurance of 3000 issued to (x).

14. Determine the variance of the present value random variable for a 12-year pure endowment of 100 issued to (x).

15. Determine the variance of the present value random variable for a 20-year term insurance of 1000 issued to (40), payable at the end of the year of death.

For Numbers 16 through 18, assume $i = .08$ and DML (global UDD) mortality with terminal age 110.

16. Determine the variance of the present value random variable for a discrete whole life insurance of 3000 issued to (60).

17. Determine the variance of the present value random variable for a 12-year pure endowment of 100 issued to (50).

18. Determine the variance of the present value random variable for a 20-year term insurance of 1000 issued to (40), payable at the end of the year of death.

19. In a double decrement model, decrement 1 is death by non-accidental means and decrement 2 is death by accident. You are given:

x	$q_x^{(1)}$	$q_x^{(2)}$
60	0.010	0.005
61	0.014	0.008

A 2-year term insurance of 10,000 issued to (60), with benefit payable at the end of the year of death, has a double indemnity clause stating that an additional 10,000 will be paid if death occurs by accidental means. Using an annual effective interest rate of 5% determine the variance of the present value random variable for this insurance product.

20. A discrete 3-year term insurance issued to (35) pays 1000 if death occurs in the first year, 750 if death occurs in the second year, and 1250 if death occurs in the third year. Given $q_{35+k} = 0.02 + 0.005k$, for $k = 0, 1$, and 2, determine the variance of the present value random variable for the insurance using $d = 0.05$.