

## Module 2 Section 2 Exercises:

For each of the following annuities in Numbers 1 through 14, draw an appropriate timeline if necessary, and use the actuarial assumptions (mortality and interest) from the L-TAM tables to determine the actuarial present value of the annuity.

1. an annuity of 5000, issued to a 35 year old, with the payment made at the beginning of each year for as long as the 35-year old is alive
2. a whole life annuity immediate of 5000 issued to (35)
3. a 17-year deferred whole life annuity due of 500 issued to (35)
4. a 17-year deferred whole life annuity immediate of 500 issued to (35)
5. a 2-year temporary annuity due of 750 issued to (32)
6. a 17-year temporary life annuity due issued to (35), with annual benefit of 8000
7. a 17-year temporary life annuity immediate of 8000 issued to (35), payable annually
8. a 17-year certain-and-life annuity due issued to (35) with annual payments of 2000
9. a 17-year certain-and-life annuity immediate issued to (35) with annual payments of 2000
10. an annual payment annuity due of 1000 issued to independent lives aged 30 and 40, with payments lasting until the first death
11. an annual payment annuity due of 1000 issued to independent lives aged 30 and 40, with payments lasting until the first death with a maximum of 10 payments
12. an annual payment annuity due of 500 issued to independent lives aged 30 and 40, with payments continuing until the last death
13. an annual payment annuity due of 500 issued to independent lives aged 30 and 40, with payments continuing until the last death with a maximum of 10 payments
14. an annual payment annuity due issued to independent lives aged 30 and 40, with payments of 1000 while both are alive, 750 continuing to the current 30-year old if the current 40-year old dies first, and 500 continuing to the current 40-year old if the current 30-year old dies first.

15. A 4-year temporary annuity due with annual payments issued to (35) pays 1000 for the first year, 750 for the second year, 1250 for the third year, and 1500 for the fourth year. Given  $q_{35+k} = 0.02 + 0.005k$ , for  $k = 0, 1, \text{ and } 2$ , determine the actuarial present value for this annuity using  $d = 0.05$ .
16. In a homogeneous Markov model with 3 states: Healthy (H), Sick (S), and Dead (D), you are given:

(i) the annual transition probabilities are

	H	S	D
H	.80	.15	.05
S	.40	.50	.10
D	0	0	1

(ii) (x) is currently healthy

A 3-year temporary annuity due with annual payments issued to (x) pays 100 if (x) is healthy and 25 if (x) is sick. Determine the actuarial present value of this annuity using an annual discount factor of 0.95.

17. A 20-year temporary life annuity due with annual payments issued to (30) has a first payment of 1000. Subsequent payments are 1% larger than their previous payments. Determine the actuarial present value of this annuity using ILT mortality and  $i = 7.06\%$ .
18. A 30-year temporary life annuity due with annual payments, issued to (x), has an initial payment of 1000. Subsequent payments are 5% more than their preceding payment. Determine its APV, given  ${}_{30}p_x = 0.4$ ,  $e_{x:\overline{30}|} = 20.7$ , and  $i = .05$ .
19. Draw the timeline, include the valuation date, that corresponds to the symbol  $100(I\ddot{a})_x$ .
20. An annual payment whole life annuity due issued to (25) pays 5 for the first year, 7 for the second year, and so on, where each year's payment is 2 more than the preceding year's benefit. Write an expression using actuarial notation for the APV of this annuity.
21. A 10-year temporary annuity issued to (50), with benefit paid at the beginning of the year, has a payment of 1500 for the first year. For subsequent years, the payment is 100 less than the previous year's benefit. Write an expression using actuarial notation for the APV of this annuity.

For Numbers 22 and 23, determine the APV of the annuity described, using  
(a) ILT actuarial assumptions and the UDD assumption between integer ages  
(b) ILT actuarial assumptions and the three term Woolhouse approximation

22. A whole life annuity issued to  $(40)$  with a benefit of 1000 payable at the beginning of each quarter
23. A 20-year deferred whole life annuity issued to  $(40)$  with a benefit of 100 payable at the beginning of each quarter
24. Determine the APV of a 20-year temporary life annuity, issued to  $(40)$ , with a benefit of 1000 paid at the beginning of each quarter, using ILT actuarial assumptions and the UDD assumption between integer ages.
25. Repeat numbers 22-24 assuming the payments are monthly instead of quarterly.