

## Errata and Updates for ASM Exam LTAM (First Edition Fifth Printing) Sorted by Page

For Practice Exam 4:B2(c), make the correction for page 1481.  
 For Practice Exam 7:B4, make the correction for page 1510.  
 For Practice Exam 7:B6, make the correction for page 1511.  
 For Practice Exam 9:B4, make the correction for page 1528.  
 For Practice Exam 12:A10, make the correction for page 1554.  
 For Practice Exam 13:A9, make the correction for page 1565.

- [7/20/2020] On page 1, on the first line of the first bullet, change “emphsurvival” to “*survival*”.
- [4/11/2020] On page 28, one line below the table, change  $\text{Var}(99, 98)$  to  $\text{Var}(0.99, 0.98)$ .
- [7/20/2020] On page 97, in the solution to exercise 6.16, on the first line, change “between 21” to “between 20”.
- [7/20/2020] On page 102, on the last line of the solution to exercise 6.30, delete “ $o5 =$ ”.
- [1/4/2021] On page 173, on the second line of the solution to Example 10D, change  $K_t$  to  $K_{t+1}$ .
- [3/7/2020] On page 174, 6 lines above Example 10F, change  $m(x, t + k)$  to  $m(x, t + n)$ .
- [4/20/2020] On page 188, in the solution to exercise 10.17, on the third line from the end, change  $p(85, 2017)$  to  $p(80, 2017)$ .
- [7/20/2020] On page 192, in exercise 11.6, change (i) to  $\mu_{x+t} = \alpha / (100 - (x + t))$ ,  $t \geq 0$ .
- [4/22/2020] On page 209, on the first line of Example 12H, put a space between “that” and “ $q_{45}$ ”.
- [1/16/2020] On pages 209–210, in Example 12H and its solution, replace  $A_{x:\overline{2}|}^{(2)}$  with  $A_{45:\overline{2}|}^{(2)}$  three times.
- [7/20/2020] On page 227, in the solution to exercise 12.18, split the last line into two, putting “Answer ...” on the second line.
- [4/23/2020] On page 235, in the solution to exercise 12.49, on the second line, change the first numerator 315 to 0.315. Replace the last two lines with

$$F_1 = 448.253(1.07) - 1000 = -520.370$$

$$F_2 = -520.370(1.069) - 500 = -1056.275$$

The excess of expected over actual is **1056.275**.

- [1/14/2020] In the alert boxes on pages 238 and 263, the SOA 283 sample questions no longer exists. The material in this lesson won’t help you much with the current sample questions.
- [4/25/2020] On page 293, three lines after the solution to Example 15J, change “ $x > n$ ” to “ $t > n$ ” and change “between  $x$  and  $n$ ” to “between  $t$  and  $n$ ”.
- [7/20/2020] On page 302, in the solution to exercise 15.16, on the second line, change the exponent on  $\left(\frac{40-t}{40}\right)$  from 0.5 to 0.3.
- [1/20/2020] On page 358, on the first line, change  $\ddot{a}_{68:\overline{20}|}$  to  $\ddot{a}_{65:\overline{20}|}$ .
- [4/18/2020] On page 403, on the seventh line from the bottom, delete  $v^n$ . Replace the sentence beginning “let  $I = 0$  if  $T_x \leq n$ ” with

But consider the *conditional* variable  $Y | T_x > n$ . Now that survival to time  $n$  is guaranteed, this variable is  $v^n \bar{a}_{\overline{T_x+n}|}$ . And of course the conditional variable  $Y | T_x \leq n$  is the constant 0. For convenience, let  $I = 0$  if  $T_x \leq n$  and 1 otherwise.

On the third line from the bottom, replace  ${}^2\bar{A}_x - \bar{A}_x^2$  with  ${}^2\bar{A}_{x+n} - \bar{A}_{x+n}^2$ . Make the same correction to the third line on page 404.

[12/15/2019] On page 460, in the solution to exercise 23.4, 2 lines after the timelines, put a period before “Adding”.

[7/21/2020] On page 464, in the solution to exercise 23.19, 4 lines before the end, change  $\ddot{a}_{67:\overline{2}|}$  to  $\ddot{a}_{67:\overline{3}|}$ .

[7/21/2020] On page 508, in the solution to exercise 26.14, on the second line, change  $-0.2$  to  $-0.02$ . On the third line, change  $0.2$  to  $0.02$ .

[5/10/2020] On page 541, replace the fifth line before the end of the solution to exercise 28.2 with

$$\alpha(12) = 1.00020 \quad \beta(12) = 0.46651$$

To be consistent, three lines before the end of the solution, replace  $1.000197$  with  $1.00020$  and  $0.466506$  with  $0.46651$ , although the more precise values are correct.

[7/21/2020] On page 595, on the first line of Example 32A, add “insurance” after “endowment”.

[7/21/2020] On page 601, on the second-to-last line of exercise 32.17, add “insurance” after “endowment”.

[4/25/2020] On page 618, on the sixth and seventh lines of the solution to Example 33G, change  $58.0944$  to  $47.3396$  (once on each line).

[2/4/2020] On page 625, in the solution to exercise 33.5, on the second line from the end, change  $\ddot{a}_{\overline{10}|}$  to  $\ddot{a}_{\overline{17}|}$ .

[5/13/2020] On page 632, one line above Example 34B, change  $14.249$  to  $14.239$ .

[6/19/2020] On page 635, in the solution to exercise 34.3, on the fifth line, change  $2.236$  to  $2.326$ .

[7/21/2020] On page 648, in the solution to exercise 35.15, on the last line, change **(AD)** to **(A)**.

[5/17/2020] On page 654, in the solution to Example 36E part 2, on the fourth line, change  $0.88392$  to  $0.77382$ .

[5/18/2020] On page 707, in the solution to Example 39C, on the fourth line, change  $E$  to  $e$ .

[7/21/2020] On page 713, in the solution to exercise 39.1, three lines before the end, change the numerator of the fraction from  $0.864048 - 746876^2$  to  $0.746876 - 0.864048^2$ . And change the final answer from  $0.000259$  to  $0.00259$ .

[4/19/2020] On page 732, in the box before exercise 40.10, replace the bottom two lines with

$$\begin{aligned} 1000P_{68} &= 34.12 & \ddot{a}_{68:\overline{20}|} &= 12.294465 \\ 1000A_{68:\overline{20}|} &= 527.14 & \ddot{a}_{85:\overline{3}|} &= 2.721092 \end{aligned}$$

[7/21/2020] On page 745, in exercise 40.60(b), on the second line, change “annual net premium” to “net level annual premium”.

[4/19/2020] On page 751, replace the solutions to exercises 40.10–40.13 with the following:

40.10 Calculate this prospectively.

$$\begin{aligned} {}_{17}V &= 1000(A_{85:\overline{3}|} - P_{68}\ddot{a}_{85:\overline{3}|}) \\ A_{85:\overline{3}|} &= 1 - d\ddot{a}_{85:\overline{3}|} = 1 - \left(\frac{0.04}{1.04}\right)(2.721092) = 0.895343 \\ {}_{17}V &= 1000(0.895343) - 34.12(2.721092) = \boxed{802.50} \end{aligned}$$

40.11 Calculate this recursively. Even though we are using a 4% interest rate, we still refer to the Standard Ultimate Life Table to obtain mortality rates. From the Standard Ultimate Life Table, we use  $q_{68} = 0.008297$  for the first recursion and  $q_{69} = 0.009294$  for the second recursion.

$${}_1V = \frac{(34.12)(1.04) - 8.297}{1 - 0.008297} = 27.4153$$

$${}_2V = \frac{(27.4153 + 34.12)(1.04) - 9.294}{1 - 0.009294} = \boxed{55.22}$$

40.12 From the Standard Ultimate Life Table, we use  $q_{73} = 0.014664$  to go from  ${}_5V$  to  ${}_6V$ .

$$\frac{(140.42 + \pi_5)(1.04) - 0.014664(1000)}{1 - 0.014664} = 190$$

$$\pi_5 = \frac{190(1 - 0.014664) + 14.664}{1.04} - 140.42 = \boxed{53.69}$$

40.13 The expected present value of the premiums is  $34.12(12.294465)$  plus the expected present value of the extra  $270 - 34.12$ , or  ${}_5E_{68}(270 - 34.12)$ , which we compute using the Standard Ultimate Life Table. We compute  ${}_5E_{68}$  by taking the value from our tables (0.74305) and multiplying it by  $(1.05/1.04)^5$  to convert it from 5% to 4%:

$${}_5E_{68} = 0.74305 \left( \frac{1.05}{1.04} \right)^5 = 0.77947$$

$$\text{PVPremis} = (34.12)(12.294465) + 0.77947(270 - 34.12) = 603.3475$$

The EPV of the benefits must match this. The EPV of the standard benefits of 1000 is  $1000A_{68:\overline{20}|} = 527.14$ . The excess of the present value of premiums over this,  $603.3475 - 527.14 = 76.2075$ , must be the EPV of the extra death benefit, which is  $({}_{15}q_{68}/1.04^{16})(b_{16} - 1000)$ . From the Standard Ultimate Life Table,

$${}_{15}q_{68} = \frac{l_{83} - l_{84}}{l_{68}} = \frac{67,614.6 - 64,506.5}{92,706.1} = 0.033526$$

Then

$$\frac{{}_{15}q_{68}}{1.04^{16}}(b_{16} - 1000) = 76.2075$$

$$b_{16} - 1000 = \frac{76.2075(1.04^{16})}{0.033526} = 4257.42$$

$$b_{16} = \boxed{5257.42}$$

[7/21/2020] On page 758, in the solution to exercise 40.41, replace the last line with

$${}_{19}V = \frac{176.4470 + 5.288}{1.05} - 6.78 = \boxed{166.30}$$

[7/21/2020] On page 776, in the solution to exercise 41.15, replace the last displayed line with

$${}_{15}V^{\text{mod}} = 235.24 - (7.0638)(4.5268) - (6.5586)(11.5331) = \boxed{127.62}$$

[11/28/2019] On page 779, on the last line, change 0.166770 to 0.16770.

[12/1/2019] On page 814, 8 lines from the bottom of the page (first line of item 1), change “vary” to “very”.

[6/1/2020] On page 855, in the solution to Example 46M, in part 2, change the final answer from 18,282.4 to 18,122.4. On the last line of the solution, change 18,282.4 to 18,122.4 and change 7,786 to 7,946.

[7/21/2020] On page 857, in exercise 46.1, all annuities should be continuous. Therefore the question should read  
A Markov chain has three states: Healthy (0), Sick (1), and Dead (2). Movement between states follows the Sickness-Death model and  $i = 0.05$ .

A 10-year deferred continuous whole life annuity on a healthy person age 55 pays 10,000 per year starting at age 65 as long as the annuitant is alive. Premiums are payable continuously for 10 years as long as the annuitant is healthy.

Calculate the annual net premium.

[7/21/2020] On pages 868–869, in the solution to exercise 46.1, all annuities should be continuous. Replace every  $\ddot{a}$  with  $\bar{a}$ . There are six  $\ddot{a}$ s.

[2/16/2020] On page 879, on the second line (expression (47.4)), change  $\ddot{a}_{x+\frac{k+1}{12}:n-\frac{k}{12}}^{(12)\overline{11}}$  to  $\bar{a}_{x+\frac{k+1}{12}:n-\frac{k+1}{12}}^{(12)\overline{11}}$ .

[2/16/2020] On page 883, in Example 47B, change the first answer from 110,800 to 104,800.

[2/20/2020] On page 886, on the third line, put the subscript  $x$  on  $\bar{A}^{ij}$ :  $\bar{A}_x^{ij}$ .

[6/2/2020] On page 886, replace the second sentence of the solution to Example 47E, which starts with “For  $\bar{A}_{x+10}^{02}$ ”, with

The annual cost of care is not included in the equation, since a whole life insurance does not pay any annuity benefits.

[7/21/2020] On page 886, after the third line of the solution to Example 47E, add:

Reentry to state 2 is possible by first going to state 1 and then to state 0, so  $\bar{A}_{x+t}^{22}$ , the EPV of an insurance that pays 1 upon reentry to state 2, is not 0. However,  $\mu_{x+t}^{02} = 0$ , so this does not affect the final formula.

On the fourth line, change  $\mu_{x+t}^{02}(1 - \bar{A}_{x+t}^{02})$  to  $\mu_{x+t}^{02}(1 + \bar{A}_{x+t}^{22} - \bar{A}_{x+t}^{02})$ .

[2/23/2020] On page 886, on the third line from the bottom, change  $0.05(\bar{A}_{x+10}^{24} - \bar{A}_{x+10}^{24})$  to  $0.05\bar{A}_{x+10}^{24}$ .

[6/2/2020] On page 887, on the third line of the page, change  $\bar{a}_{x+10}^{01}$  to  $\bar{a}_{x+10}^{10}$ .

[7/21/2020] On page 887, on the third line of Example 47E, change “if the accelerated death benefit was not used,” to “if the insured was never chronically ill;”.

[2/23/2020] On page 888, four lines from the bottom, change  $p_{x+2}^{(13)}$  to  $p_{x+2}^{13}$ .

[6/4/2020] On page 896, in exercise 47.10, in statement (i), delete  $\bar{A}_{57}^{01} = 0.23645$ . In statement (ii), delete  $\bar{A}_{67}^{01} = 0.33642$ .

[6/5/2020] On page 899, in exercise 47.12, on the fourth line, add “if alive at that time” after “subsequent years”.

[6/5/2020] On page 899, in exercise 47.13, 2 lines from the end, delete “of”.

[8/23/2020] On page 906, make the following corrections to the solution to exercise 47.2:

- On the fifth line, change  $e^{-0.0105t}$  to  $e^{-0.105t}$ .
- On the ninth and tenth lines, change  $e^{-1.305}$  to  $e^{-1.2}$ .
- On the eleventh line, change 0.382728 to 0.425100 and change 0.125572 to 0.072607.
- On the last line, change  $A_1 + A_2$  to  $\frac{50,000(A_1 + A_2)}{8.815557}$

- On the last line, change 0.125572 to 0.072607 and change the final answer to **12,857.56**.

[6/4/2020] On page 906, replace the solution to exercise 47.10 with

We need  $\bar{A}_x^{01}$  and  $\bar{A}_x^{02}$  for  $x = 57, 67$ .  $\bar{a}_x^{33}$  is the present value of a perpetuity, so it is  $1/0.05 = 20$ . Then  $\bar{a}_x^{03}$  is the EPV of an insurance that pays 20 if and when reaching state 3, so it equals  $20\bar{A}_x^{03}$ . Similarly,  $\bar{a}_x^{02} = 20\bar{A}_x^{02}$ . Also,  $\bar{a}_x^{01} + \bar{a}_x^{03}$  is the EPV of a perpetuity paying 1 per year if and when reaching state 1, so  $\bar{a}_x^{01} + \bar{a}_x^{03} = 20\bar{A}^{01}$ . And  $\bar{a}_x^{00} + \bar{a}_x^{01} + \bar{a}_x^{02} + \bar{a}_x^{03} = 20$  since it is the present value of a perpetuity. Putting this all together:

$$\begin{aligned}\bar{A}_x^{01} &= \frac{\bar{a}_x^{01} + 20\bar{A}_x^{03}}{20} = \frac{\bar{a}_x^{01}}{20} + \bar{A}_x^{03} \\ \bar{A}_{57}^{01} &= \frac{2.18}{20} + 0.16344 = 0.27244 \\ \bar{A}_{67}^{01} &= \frac{1.59}{20} + 0.20021 = 0.27971 \\ \bar{A}_x^{02} &= \frac{20 - \bar{a}_x^{00} - \bar{a}_x^{01} - 20\bar{A}_x^{03}}{20} \\ \bar{A}_{57}^{02} &= \frac{20 - 11.55 - 2.18 - 20(0.16344)}{20} = 0.15006 \\ \bar{A}_{67}^{02} &= \frac{20 - 8.21 - 1.59 - 20(0.20021)}{20} = 0.30979\end{aligned}$$

The net premium is

$$\begin{aligned}P &= \frac{70,000\bar{A}_{57}^{01} + 100,000\bar{A}_{57}^{02} + 30,000\bar{A}_{57}^{03}}{\bar{a}_{57}^{00}} \\ &= \frac{70,000(0.27244) + 100,000(0.15006) + 30,000(0.16344)}{11.55} = 3374.892\end{aligned}$$

The reserve at time 10 is

$$\begin{aligned}_{10}V^{(0)} &= 70,000\bar{A}_{67}^{01} + 100,000\bar{A}_{67}^{02} + 30,000\bar{A}_{67}^{03} - P\bar{a}_{67}^{00} \\ &= 70,000(0.27971) + 100,000(0.30979) + 30,000(0.20021) - 3374.892(8.21) = \mathbf{28,857.14}\end{aligned}$$

[6/5/2020] On page 909, in the solution to exercise 47.12, on the seventh line, delete “but we don’t pay 10,000... at the end of the year.”

[7/19/2020] On page 921, two lines below equation (48.6), change “ $t^{\text{th}}$  year” to “ $k^{\text{th}}$  year”.

[1/14/2020] On page 940, in the solution to exercise 48.29, on the third line, change  ${}_k p^{(45)}(0.004)$  to  ${}_k p^{(\tau)}(0.004)$

[7/21/2020] On page 972, in exercise 50.1, on the second line, change  ${}_4 p_{50}^1$  to  ${}_4 p_{50}^{(1)}$ . On the third line, change  ${}_4 p_{50}^2$  to  ${}_4 p_{50}^{(2)}$ . In exercise 50.2, on the fourth line, change  $p_x^2$  to  $p_x^{(2)}$ .

[7/19/2020] On page 993, in the solution to exercise 51.6, on the first line, change  ${}_3 p_0^{(j)}$  to  ${}_2 p_0^{(j)}$ .

[7/21/2020] On page 1002, on the second line of the solution to Example 52D, replace the clause after the semicolon with

in the absence of decrement 1, 30% of the population at time 0 is decremented at time 1 by decrement 2.

[7/21/2020] On page 1067, in the solution to exercise 56.16, on the second line, change  ${}_5 p_{90:90}$  to  ${}_5 q_{90:90}$ .

- [7/21/2020] On page 1097, in exercise 58.16(ii), change  $i = 0.05$  to  $\mu = 0.05$ .
- [2/9/2020] On page 1113, in the solution to exercise 59.2, on the first line, change “(il) and (iii)” to “(i) and (ii)”.
- [3/9/2021] On page 1114, in the solution to exercise 59.6, on the third line, change  $\mu_{x+t:y+t}^{01}$  to  $\mu_{x+t:y+t}^{02}$ .
- [2/9/2020] On page 1118, on the second line under “Non-independent lives”, add a period after the second integral before “For”.
- [2/10/2020] On page 1124, in exercise 60.6, on the second line, change “annual” to “Annual”.
- [6/22/2020] On page 1128, in exercise 60.23, on the first line, add “with” between “Markov chain” and “the”.
- [6/22/2020] On page 1147, in the solution to exercise 60.34, on the second line, add at the end of the sentence “if (y) dies first”.
- [7/22/2020] On page 1147, in the solution to exercise 60.39, on the first line, change  ${}_{10|10}q_{30:40}$  to  ${}_{10|10}\overline{q}_{30:40}$ .
- [2/13/2020] On page 1150, in the solution to exercise 60.48, on the last line, change  $E[X]$  to  $E[Z]$ .
- [6/23/2020] On page 1167, in the solution to exercise 61.1, remove the comma after  $v^5$  on the first line. On the fifth line, change  $a_{30:40:\overline{10}|}$  to  $a_{30:40:\overline{5}|}$  and  ${}_{10}E_{30:40} a_{35:45}$  to  ${}_5E_{30:40} a_{35:45}$ .
- [6/26/2020] On page 1276, exercise 68.12 is missing answer choices. Add the following line at the end:

(A) 10                      (B) 12                      (C) 15                      (D) 17                      (E) 18

- [7/22/2020] On page 1286, in the solution to exercise 68.25, on the first line, replace “eq:VarSnextrap” with “(68.6)”.
- [7/22/2020] On page 1291, on line 5 of the second paragraph, change “survival survivals” to “survival probabilities”.
- [3/7/2020] On page 1319, 3 lines above Section 70.1, delete one of the two “benefit” s.
- [3/8/2020] On page 1321, on the first line, add “to” before “estimate”.
- [3/9/2020] On page 1323, on the first two lines of Example 70G, change “death, withdrawal, disability, and retirement” to “withdrawal, disability, retirement, and death”.
- [3/9/2020] On page 1325, on the fifth line, change 17 to 27.
- [3/13/2020] On page 1327, on the sixth line of the solution to Example 70J, change “retirement” to “withdrawal” twice.
- [3/13/2020] On page 1335, on the sixth line of ths solution to Example 70J, change “retirement” to “withdrawal” twice.
- [7/22/2020] On page 1339, replace the solution to exercise 70.18 with
- We need to calculate the probability of retirement at each age. From the wording of the retirement probabilities, we are given independent associated single decrements that happen one after the other. So we calculate probability of survivors to age 63, multiply that by 10% to get retiree count, subtract that, and then do the same at age 64. In the following table, all  $l_x$  and  $q_x$  are from the Standard Ultimate Life Table, and “non-retirement probability” is the probability of survival to the indicated age and not

retiring at that age.

Age $x$	Survivorship probability ${}_{x-45}p_{45}^{(\tau)}$	Retirement probability ${}_{x-45}q_{45}^{(r)}$	Non-retirement probability
63	$\frac{l_{63}}{l_{45}} = \frac{95,534.4}{99,033.9} = 0.964664$	$0.1(0.964664) = 0.096466$	$0.964664 - 0.096466 = 0.868197$
64	$0.868197p_{63} = 0.868197(1 - 0.004730) = 0.864091$	$0.1(0.864091) = 0.086409$	$0.864091 - 0.086409 = 0.777682$
65	$0.777682p_{64} = 0.777682(1 - 0.005288) = 0.773569$	$0.773569$	

The annual payment under the pension is  $(10)(0.02)(100,000) = 20,000$  before reduction for early retirement.

We use the values of  $\ddot{a}_x$ ,  $x = 63, 64, 65$  found in the Standard Ultimate Life Table for the retirement annuity values. The following table lists the factors we use:

Age	Reduction Factor	Retirement Probability	$\ddot{a}_x$	Discount Factor
63	0.8	0.086820	14.1151	$1/1.05^{18}$
64	0.9	0.077768	13.8363	$1/1.05^{19}$
65	1.0	0.773569	13.5498	$1/1.05^{20}$

The expected present value of the retirement benefit is

$$20,000 \left( \frac{(0.8)(0.096466)(14.1151)}{1.05^{18}} + \frac{(0.9)(0.086409)(13.8363)}{1.05^{19}} + \frac{(0.773569)(13.5498)}{1.05^{20}} \right) = \boxed{96,577.88}$$

- [3/20/2020] On page 1344, on the fourth line of the solution to Example 71C, change 94.020.3 to 94.579.7.
- [3/21/2020] On page 1344, two lines after the displayed line ending with the highlighted answer 3116.27, change 1.22194 to 2.66952.
- [7/6/2020] On page 1348, on the fourth line after Table 71.1, delete “to” between “may” and “use”.
- [7/22/2020] On page 1349, in exercise 71.3, replace (iii) with  
The expected amount of money that the plan will pay during the year for exit benefits is 10,105.
- [7/6/2020] On page 1350, in exercise 71.5, add the following statement after (v):  
(vi) There are no exits from the pension plan within the first 10 years of service.
- [3/22/2020] On page 1354, in the solution to exercise 71.2, on the first line, change “calculating” to “calculated”.
- [3/23/2020] On page 1356, in the solution to exercise 71.13, on the fourth line, change “6%” to “5%”.
- [3/24/2020] On page 1359, one line after equation (72.1), change  $a_B(x, t)$  to  $\ddot{a}_B(x, t)$ .
- [3/24/2020] On page 1360, two lines below equation (72.4), change  $(1 + (i^*)^t)$  to  $(1 + i^*)^t$ .
- [7/9/2020] On page 1367, in the solution to exercise 72.5, on the third line, the fraction should be inverted; change  $\frac{1.04}{1.005(1.05)}$  to  $\frac{1.005(1.05)}{1.04}$ .

- [3/27/2019] On page 1371, on the last line of the fourth paragraph, change “higher of lower” to “higher or lower”.
- [3/28/2020] On page 1375, on the second line of the page, change “year  $t$ ” with “year  $k$ ”.
- [3/31/2020] On page 1378, two lines from the bottom, change “the each” to “each” (delete “the”).
- [4/6/2020] On page 1393, in the solution to exercise 73.20, on the fourth line, change  $-80$  to  $80$ .
- [7/22/2020] On page 1409, in exercise 75.8, change  $0.002k$  to  $0.002j$ .
- [7/22/2020] On page 1481, in question 2(c), change 26 to 16.
- [7/22/2020] On page 1499, in question 20(i), change “years” to “year”.
- [7/22/2020] On page 1510, in question 4(b), on the third line, change “1.3” to “1.2”.
- [7/22/2020] On page 1511, in question 6(b), delete “, using  $i=0.06$ ”. In question 6(f), change “It” to “it”.
- [7/19/2020] On page 1518, in question B1 (iii), change 10,000,000 to 100,000.
- [7/22/2020] On page 1530, in question 4(e), change “(c)” to “(d)”.
- [6/23/2020] On page 1554, in question 10, on the second line from the end, change  ${}_0V = 2711.75$  to  ${}_0V = 0$ .
- [7/22/2020] On page 1561, in the schematic diagram, change “4” in the Dead box to “3”.
- [7/22/2020] On page 1565, in question 9, change the headings in the table from  $d_j, x_j, u_j$  to  $n_j, d_j, w_j$  respectively.
- [9/18/2021] On page 1592, in the solution to question 2(b), change 174,349.35 to 177,686.10 on the last two lines, once apiece on each line. In the solution to question 2(c), on the last line, change 174,349.35 to 177,686.10 and change 11,325.02 to 11,450.14.
- [7/22/2020] On page 1609, on the last line of the page, change “MLC” to “LTAM”.
- [7/22/2020] On page 1615, in the solution to question 2(a), on the first line, change  $-26\ddot{a}_{55}$  to  $-16\ddot{a}_{55}$ . In the solution to question 2(b), change the last two lines to

$$258.2065 - 15.57760G = 0$$

so  $G = \boxed{16.5755}$ .

- [7/22/2020] On page 1627, at the end of the solution to question 2(a), delete the stray “S”.
- [7/22/2020] On page 1628, in the solution to question 3(b), change the last two lines to

$$1000(8.10782) + (x - 1000)(8.10782 - 7.9555) = 7955.5 + 0.1523x$$

The total EPV is  $14,321.1 + 2.7562x$ . Equating to 17,599.7, we get  $x = \boxed{1189.5}$ .

- [7/22/2020] On page 1629, in the solution to question 4(c), remove the framed shaded box from 9.9409 and add the following line after that line:

$$10,000 {}_2| \ddot{a}_{66} = \boxed{99,409}$$

- [7/22/2020] On page 1653, replace the solution to question 6(b) with

The EPV at age 65 of the life annuity-due is  $137,315.6\ddot{a}_{65} = 137,315.6(13.5498) = 1,860,600$ . Discounting to age 35,

$$1,860,600 {}_{30}E_{35} = 1,358,999(0.61069)(0.35994) = \boxed{408,982}$$

- [7/22/2020] On page 1660, replace the solution to question 19 with



We need to calculate the present value of exit benefits. Three times salary is 180,000.

$$\frac{180,000q_{40}}{(1+i)^{0.5}} = \frac{180,000(0.000527)}{1.05^{0.5}} = 92.57$$

The normal contribution is

$$62,537vp_{40} + 92.57 - 55,647 = 62,537\left(\frac{1-0.000527}{1.05}\right) + 92.57 - 55,647 = \boxed{3973} \quad (\mathbf{D})$$

[7/19/2020] On pages 1660–1661, replace the solution to question 1(b)–(c) with

- (b)  ${}_2p_{40}$  in Standard Ultimate Life Table is  $l_{42}/l_{40} = 99,229.8/99,338.3$ . In your table,  $\mu$  is 0.0001 lower, so

$${}_2p_{40} = \left(\frac{99,229.8}{99,338.3}\right)e^{0.0001(2)} = 0.999108$$

Select mortality is that probability raised to the 0.8, or  $0.999108^{0.8} = 0.999286$ . Working backwards from  $l_{42}$ , we get  $l_{[40]} = 99,448.3/0.999286 = \boxed{99,519.4}$ .

- (c) It's easier to work with annuity factors than directly with premium factors. Note that  $d = 1 - v = 0.05$ .

$$\ddot{a}_{[41]+1} = \frac{1}{P_{[41]+1} + d} = \frac{1}{0.003 + 0.05} = 18.86792$$

Do recursion to 43, then to 42, then to  $[40] + 1$ .

$$p_{[41]+1} = (p_{42}^{\text{SULT}} e^{0.0005})^{0.8} = ((1 - 0.000608)e^{0.0001})^{0.8} = 0.999594$$

$$\ddot{a}_{43} = \frac{\ddot{a}_{[41]+1} - 1}{vp_{[41]+1}} = \frac{17.86792}{0.95(0.999594)} = 18.81599$$

$$p_{42} = p_{42}^{\text{SULT}} e^{0.0001} = (1 - 0.000608)e^{0.0001} = 0.999492$$

$$\ddot{a}_{42} = 1 + vp_{42}\ddot{a}_{43} = 1 + (0.95)(0.999492)(18.81599) = 18.86611$$

$$p_{[40]+1} = (p_{41}^{\text{SULT}} e^{0.0001})^{0.8} = ((1 - 0.000565)e^{0.0001})^{0.8} = 0.999628$$

$$\ddot{a}_{[40]+1} = 1 + (0.95)(0.999628)(18.86611) = 18.91613$$

$$P_{[40]+1} = \frac{1}{\ddot{a}_{[40]+1}} - d = \frac{1}{18.91613} - 0.05 = \boxed{0.002865}$$

[7/22/2020] On page 1663, in the solution to question 5(a) and 5(b), change 3195.1 to 319.51 in the two places it appears.

[7/22/2020] On page 1669, in the solution to question 14, replace the answer key **(D)** with **(C)**. Also correct the answer key on page 1666.

[7/22/2020] On page 1670, in the solution to question 17, replace the answer key **(E)** with **(B)**. Also correct the answer key on page 1666.

[7/22/2020] On page 1687, in the solution to question 6:

- In part (a), on the second displayed line, change 17,295.00 to 16,491.72.
- In part (c), on the third line from the end, change 0.03(120,178.6) to 0.03(20,178.6).

- Replace the solution to part (d) with

As calculated in part (b), annual benefit accrual with projected career average is 2605.36. With 35 years of service, the annual pension is  $25(2605.36) = 65,134$ . Final salary is  $100,000(1.025^{19}) = 159,865$ . The replacement ratio is  $65,134/159,865 = \boxed{0.4074}$ .

[7/22/2020] On page 1691, in the solution to question 13, on the second and seventh lines, change 0.37135 to 0.36135.

[7/23/2020] On page 1693, in the solution to question 1(a), change the final answer to 65,685.58.

[7/23/2020] On page 1696, in the solution to question 4(c), change the last 3 lines to

$$\begin{aligned} &= 0.02e^{-0.5} \int_0^{10} t e^{-0.0075t^2} dt \\ &= -\frac{0.02e^{-0.5}}{0.015} e^{-0.0075t^2} \Big|_0^{10} \\ &= -\frac{0.02e^{-0.5}}{0.015} (e^{-0.75} - 1) = \boxed{0.426701} \end{aligned}$$

In the solution to question 4(d), on the last line, change 0.353206 to 0.426701 and change 0.360289 to 0.286794.

[7/23/2020] On page 1700, in the solution to question 4, on the second-to-last line, change  $e_{68}$  to  $e_{68}^2$ .

[7/23/2020] On page 1701, in the solution to question 9, change the answer key to (A). Also change the answer key on page 1699 accordingly.

[6/23/2020] On page 1701, in the solution to question 10, delete the second sentence “The initial reserve...”.

[7/23/2020] On page 1708, in the solution to question 6(c), on the second-to-last line, change  $s329.72$  to  $2329.72$ .

[7/23/2020] On page 1716, replace the last 3 lines of the solution to question 2(c) with

Linearly interpolating between  $l_{94}$  and  $l_{95}^-$ ,

$$\frac{25,094.3 - 24,834.6}{25,094.3 - 21,569.9} = 0.07369$$

The third quartile of survival time is  $\boxed{54.07369}$ .

[8/2/2020] On page 1720, replace the last 3 lines of the solution to question 6(c) with

$$e^{-0.06(16)} ({}_{16}p^{00} + {}_{16}p^{02}) = e^{-0.96} \left( e^{-0.72(16)} + \frac{3}{7}(e^{-0.02(16)} - e^{-0.72(16)}) \right) = 0.293089$$

The sum of these amounts multiplied by 100,000 is

$$100,000(0.025641 + 0.066364 + 0.293089) = \boxed{38,509.37}$$

[4/18/2020] On page 1835, in the solution to question 2(b), change  ${}_5\bar{a}_x$  to  $1000{}_5\bar{a}_x$ .

[4/18/2020] On page 1836, in the solution to question 2(c)(ii), on the first and fourth lines, change  $v^5\bar{a}_{x+5}$  to  $1000v^5\bar{a}_{x+5}$ .

[5/4/2020] On page 1853, in the solution to question B1(c), on the second line from the end, change  $(0.95(1283.08)v^{0.3} - 50)$  to  $(0.95(1283.08) - 50)v^{0.3}$ .

[5/4/2020] On page 1853, in the solution to question B2(c) on the second line, change  ${}_{10\frac{1}{12}}V^0$  to  ${}_{10\frac{1}{12}}V^{(0)}$ .

[6/23/2020] On page 1856, in the solution to question B6(a), on the third line, change “item” to “items”. On page 1857, in the solution to question B6(b), on the third line, replace  $p_{65}^{(d)}$  with  $p_{65}^{(d)}$ . Replace the solution to question B6(c) with

$$NPV = \Pi_0 + \frac{\Pi_1}{1+r} + \sum_{k=2}^{\infty} \frac{\Pi_k}{(1+r)^k} = 8860$$

with  $\Pi_k$  being the  $k^{\text{th}}$  component of the profit signature.  $\Pi_k$  is the profit in year  $k$  per policy issued, while  $\text{Pr}_k$  is the profit per policy in year  $k$  per policy in force at the beginning of year  $k$ , so

$$\Pi_k = \begin{cases} \text{Pr}_k & k = 0, 1 \\ {}_{k-1}p_{65}^{(\tau)} \text{Pr}_k & k \geq 2 \end{cases}$$

so

$$NPV = \text{Pr}_0 + \frac{\text{Pr}_1}{1+r} + \sum_{k=2}^{\infty} {}_{k-1}p_{65}^{(\tau)} \frac{\text{Pr}_k}{(1+r)^k} = 8860$$

We want the second year profit  $\text{Pr}_2$  discounted with one year of interest, plus the third year profit discounted with one year of survivorship and two years of interest, and so on, or

$$\sum_{k=2}^{\infty} {}_{k-2}p_{66}^{(\tau)} \frac{\text{Pr}_k}{(1+r)^{k-1}}$$

Now,  ${}_{k-2}p_{66}^{(\tau)} = {}_{k-1}p_{65}^{(\tau)} / p_{65}^{(\tau)}$ .

Starting with NPV, we remove  $\text{Pr}_0$  and  $\text{Pr}_1 / (1+r)$ . The remainder is multiplied by  $1+r$  and divided by  $p_{65}^{(\tau)}$ . We get

$$p_{65}^{(\tau)} = (1 - q_{65}^{(d)})(1 - q_{65}^{(w)}) = (1 - 0.005324)(1 - 0.03) = 0.964836$$

$$\text{Answer} = \left( 8860 - (-7500) - \frac{1095.95}{1.1} \right) \left( \frac{1.1}{0.964836} \right) = \boxed{17,515.98}$$