

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

See correction to Practice Exam 3:B6 below (page 1482).

For Practice Exam 4:B2(c), make the correction for page 1479.

Practice Exam 7:A8 is defective in that none of the five answer choices is correct.

For Practice Exam 7:B4, make the correction for page 1520.

For Practice Exam 7:B6, make the correction for page 1521.

For Practice Exam 9:B4, make the correction for page 1538.

For Practice Exam 12:A10, make the correction for page 1562.

Make the correction to 12:B2(b)(ii) indicated below, page 1566.

For Practice Exam 13:A9, make the correction for page 1573.

- [7/20/2020] On page 1, on the first line of the first bullet, change “emphsurvival” to “*survival*”.
- [12/6/2018] On page 27, on the last line of the solution to Example 3F, change **60.2753** to **63.4821**.
- [4/11/2020] On page 28, one line below the table, change $\text{Var}(99, 98)$ to $\text{Var}(0.99, 0.98)$.
- [9/21/2019] On page 93, in exercise 6.36, change $0 \leq x \leq \omega$ to $0 \leq t \leq \omega$.
- [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 101, on the last line of the solution to exercise 6.30, delete “ $o5 =$ ”.
- [5/24/2019] On page 160, in the solution to exercise 9.17, on the first line, change l_{80} to $l_{[80]}$.
- [3/7/2020] On page 174, 6 lines above Example 10F, change $m(x, t + k)$ to $m(x, t + n)$.
- [8/9/2019] On page 188, in the solution to exercise 10.17, on the second line, change $0.01Z_{2017}^{(2)}$ to $0.05Z_{2017}^{(2)}$.
- [4/20/2020] On page 188, in the solution to exercise 10.17, on the third line from the end, change $lm(80, 2017)$ to $lq(80, 2017)$. Also change $p(85, 2017)$ to $p(80, 2017)$.
- [7/20/2020] On page 192, in exercise 11.6, change (i) to $\mu_{x+t} = \alpha/(100 - (x + t))$, $t \geq 0$.
- [3/19/2019] On page 202, in equations (12.1) and (12.2), change b_k to b_{k+1} twice in each equation.
- [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 $A_{\frac{1}{x:2}}^{(2)}$ with $A_{\frac{1}{45:2}}^{(2)}$ 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.
- [3/20/2019] On page 229, in the solution to exercise 12.24, change the last two displayed lines to

$$5_{40|}A_{30} = 5(0.12973)(0.42818) = 0.27774$$

$$\text{Answer} = 0.3849 + 0.27774 = \mathbf{0.66264}$$

- [10/1/2019] On page 235, in the solution to exercise 12.47, on the fifth line, change the denominator 0.996 to 0.988.
- [3/21/2019] Replace the solution to exercise 12.49 with

The single net premium for one policy is

$$1000vq_{30} + 500v^2p_{30}q_{31} = \frac{315}{1.05} + \frac{500(0.000327)(1 - 0.000315)}{1.05^2} = 0.448806$$

The expected size of the fund at the end of two years with this premium is zero, by the definition of the single net premium; the single net premium is the expected present value of the benefits. The actual size of the fund is obtained by recursion. Let F_t be the fund at time t .

$$F_1 = 448.806(1.07) - 1000 = -519.778$$

$$F_2 = -519.778(1.069) - 500 = \boxed{-1055.643}$$

[1/14/2020] In the alert box, 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.

[10/15/2019] On page 308, in Example 16B(iii), change $t\%$ to 5%.

[10/15/2019] On page 336, in the solution to Example 17A, on the second line change q_{47} to q_{67} . On the third line change q_{48} to q_{68} .

[10/17/2019] On page 358, on the first line, change ${}_{20}E_{85}$ to ${}_{20}E_{65}$.

[8/7/2019] On page 379, in the solution to exercise 19.39, replace the last two lines with

$${}_{30|}\ddot{a}_{30} = {}_{30}E_{30} \ddot{a}_{60} = (0.22420)(14.9041) = 3.3415$$

$$P = \frac{200{}_{30|}\ddot{a}_{30}}{1 - A_{30:30}^1} = \frac{(200)(3.3415)}{1 - 0.01190} = \boxed{676.35}$$

[10/22/2019] On page 401, on the second line of the second paragraph, change equation (20.2) to equation (20.1).

[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 $\ddot{a}_{67:2}$ to $\ddot{a}_{67:3}$.

[10/31/2019] On page 468, two lines above Example 24A, delete the words "used to".

[5/24/2019] On page 478, in the solution to exercise 24.13, this solution is based on the old Illustrative Life Tables, which has interest functions at 6%. The current Standard Ultimate Life Table gives interest functions at 5%, so you would have to calculate all interest functions from first principles if you did not have the Illustrative Life Tables available.

[1/15/2019] On page 499, in exercise 26.12, delete the answer choices.

[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 .

[10/30/2019] On page 508, replace the solution to exercise 26.18 with

The EPV of the special insurance is

$$A_{30:\overline{20}|}^1 + 5(A_{30} - A_{30:\overline{20}|}^1)$$

We calculate this expression. In the Standard Ultimate Life Table, $A_{30} = 0.07698$, and

$$\begin{aligned} A_{30:\overline{20}|}^1 &= A_{30:\overline{20}|} - {}_{20}E_{30} \\ &= 0.37900 - 0.37254 = 0.00646 \end{aligned}$$

$$\text{EPV of insurance} = 0.00646 + 5(0.07698 - 0.00646) = 0.35906$$

We calculate the expected present value of a premium annuity of 1 for 20 years, 5 for 15 years afterwards. In the Standard Ultimate Life Table, $\ddot{a}_{30:\overline{20}|} = 13.0410$.

$$\begin{aligned} \text{EPV of annuity} &= \ddot{a}_{30:\overline{20}|} + 5(\ddot{a}_{30:\overline{35}|} - \ddot{a}_{30:\overline{20}|}) \\ &= 13.0410 + 5(17.0537 - 13.0410) = 33.1045 \end{aligned}$$

The initial annual net premium is therefore $0.35906/33.1045 = \boxed{0.01085}$.

[11/3/2019] On page 531, in the solution to exercise 27.25, on the sixth line, delete the answer key **(E)**. No answer choices are provided for this question.

[11/3/2019] On page 536, in Example 28C, add

(v) Deaths are uniformly distributed between integral ages.

The values for $\alpha(4)$ and $\beta(4)$ in the solution were taken from the old exam tables; current tables give those functions at 5%.

[5/10/2020] On page 540, 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.

[11/6/2019] On page 573, replace the solution to exercise 30.10 with

The expected present value of benefits and expenses not a percentage of premium is

$$\begin{aligned} &1000(A_{40:\overline{20}|} - {}_{20}E_{40}) + 5 + 5\ddot{a}_{40:\overline{20}|} \\ &= 1000(0.38126 - 0.36663) + 10 + 5(12.9935) = 84.5975 \end{aligned}$$

The expected present value of a payment of 1 per year for 10 years minus 29% in the first year and 9% in the other 9 years is

$$\begin{aligned} &0.91\ddot{a}_{40:\overline{10}|} - 0.20 \\ &= 0.91(8.0863) - 0.20 = 7.158533 \end{aligned}$$

The quotient is $84.5975/7.158533 = \boxed{11.8177}$.

[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 $\ddot{a}_{10|}$ to $\ddot{a}_{17|}$.

[1/26/2019] On page 628, in the solution to exercise 33.19, replace the last four lines with

The present value of the death benefit is $1.05^{-43.1290} = 0.121935$. The present value of a unit annuity-due certain for 44 years (since it is a discrete annuity) is $(1 - 1.05^{-33})/(0.05/1.05) = 18.54591$. Therefore, the premium is

$$0.121935 - 18.54591\pi_b = -0.1$$

$$\pi_b = \frac{0.1 + 0.121935}{18.54591} = \boxed{0.011967}$$

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

[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 .

[6/20/2020] 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.

[11/18/2019] On page 718, in the solution to Quiz 39-1, on the second line, change ${}_tq_x$ to ${}_k|q_x$.

[11/22/2019] On page 725, on the second line, change “time t ” to “time k ”.

[4/2/2019] On page 725, in Example 40E, on the third line, change “6% interest” to “5% interest”.

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

$$1000P_{68} = 34.12 \qquad \ddot{a}_{68:\overline{20}|} = 12.294465$$

$$1000A_{68:\overline{20}|} = 527.14 \qquad \ddot{a}_{85:\overline{3}|} = 2.721092$$

[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.

$${}_{17}V = 1000(A_{85:\overline{3}|} - P_{68}\ddot{a}_{85:\overline{3}|})$$

$$A_{85:\overline{3}|} = 1 - d\ddot{a}_{85:\overline{3}|} = 1 - \left(\frac{0.04}{1.04}\right)(2.721092) = 0.895343$$

$${}_{17}V = 1000(0.895343) - 34.12(2.721092) = \boxed{802.50}$$

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%:

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

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

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

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

[2/5/2019] On page 762, in the solution to exercise 40.61, change the last line to

$$G = \frac{6.4263}{3.4869} = \boxed{1.8430}$$

Change the last line of the solution to exercise 40.62 to

$${}_1V^g = \frac{(1.8430(0.3) - 1.2 - 1)(1.05) - 0.527}{1 - 0.000527} = \boxed{-2.2576}$$

[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”.

[10/22/2019] On page 822, in the solution to exercise 44.9, on the last line, change ${}_2p_{[x]+2}^{11}$ to ${}_2p_{[x]+1}^{11}$.

[4/4/2019] On page 848, replace Example 46F and its solution with:

EXAMPLE 46F Using the Sickness-Death Model at $i = 0.05$, calculate the expected present value of a temporary 10-year continuous annuity paying 1 per year while in state 0 for someone age 55 currently in state 0.

SOLUTION: We start with a whole life annuity and subtract a 10-year deferred whole life annuity. After 10 years the person may be in state 0 or state 1, and we must consider the EPVs of annuities on individuals age 65 in either state.

$$\begin{aligned} {}_{10|\bar{a}}_{55}^{00} &= v^{10}({}_{10}p_{55}^{00} \bar{a}_{65}^{00} + {}_{10}p_{55}^{01} \bar{a}_{65}^{10}) \\ &= \frac{(0.74091)(6.6338) + (0.11682)(0.0395)}{1.05^{10}} = 3.0202 \\ \bar{a}_{55:\overline{10}|}^{00} &= 10.1228 - 3.0202 = \boxed{7.1026} \end{aligned}$$

[4/4/2019] On page 852, change the first displayed line of Subsection 46.3.2 to

$$A_{x:\overline{n}|}^{ij} = A_x^{ij} - v^n \sum_{k=0}^{n-1} {}_k p_x^{ik} A_{x+k}^{kj}$$

[4/4/2019] On page 852, regarding Subsection 46.3.3, note that this method is only a time-saver if the value of the insurance or annuity in the second state is a constant. This is usually true only if the insurance or annuity is whole life and the force of transition out of the state is constant.

[2/27/2019] On page 852, change the solution to Example 46L to

The actuarial present value for a direct transition from state 0 to state 2 (not going through state 1) is

$$\int_0^{\infty} e^{-0.06t} e^{-0.12t} (0.10) dt = \frac{10}{18} = \frac{5}{9}$$

To calculate the actuarial present value for a transition to state 1 and then to state 2, we first calculate \bar{A}_x^{12} . In state 1, we have the alive/dead model. When the force of mortality is constant,

$$\bar{A}_x^{12} = \frac{\mu}{\mu + \delta} = \frac{0.03}{0.03 + 0.06} = \frac{1}{3}$$

Now treat the insurance as an insurance for transition from state 0 to state 1 that pays 1/3 upon transition.

$$\bar{A}_x^{01} = \int_0^{\infty} e^{-0.06t} e^{-0.12t} (0.02) dt = \frac{2}{18} = \frac{1}{9}$$

Then the actuarial present value of the insurance for transition to state 2 through state 1 is $(\frac{1}{3})(\frac{1}{9}) = \frac{1}{27}$.

Total actuarial present value of the insurance is $5/9 + 1/27 = \boxed{16/27}$.

[6/1/2020] On page 853, 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, which is on page 854, change 18,282.4 to 18,122.4 and change 7,786 to 7,946.

[4/7/2019] On page 854, on the third displayed line, $(1+i)^h$ is missing from the left side. Change the line to

$${}_t V^{(1)}(1+i)^h = {}_h p_{x+t}^{11} ({}_h B_{t+h}^{(1)} + {}_{t+h} V^{(1)})$$

[7/21/2020] On page 856, 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 page 867, on the third line, replace 5.2031 with 7.1026. This affects the rest of the solution. Also replace every \ddot{a} with \bar{a} . There are six \ddot{a} s. The corrected solution to the exercise is

The EPV of 1 per year of premium payments in the healthy state only is

$$\begin{aligned} \bar{a}_{55}^{00} - v^{10}({}_{10}p_{55}^{00}\bar{a}_{65}^{00} + {}_{10}p_{55}^{01}\bar{a}_{65}^{10}) \\ = 10.1228 - \frac{(0.74091)(6.6338) + (0.11682)(0.0395)}{1.05^{10}} = 7.1026 \end{aligned}$$

The EPV of 1 unit of the benefits starting at age 65 in state 0 is \bar{a}_{55}^{00} minus the premium annuity we just computed, or $10.1228 - 7.1026 = 3.0202$. But we also want the EPV of 1 unit of benefits starting at age 65 in state 1. So we'll compute $v^{10}({}_{10}p_{55}^{00}\bar{a}_{65}^{01} + {}_{10}p_{55}^{01}\bar{a}_{65}^{11})$.

$$\frac{(0.74091)(2.8851) + (0.11682)(8.8123)}{1.05^{10}} = 1.9443$$

The annual net premium is

$$10,000 \left(\frac{3.0202 + 1.9443}{7.1026} \right) = \boxed{6,989.80}$$

[9/10/2019] On pages 868–869, replace the somewhat confusing solution to exercise 46.6 with the following:

Ignoring death, the transition probability matrix for the states low risk, medium risk, and high risk, in that order, is

$$\begin{pmatrix} 0.6 & 0.4 & 0 \\ 0.2 & 0.5 & 0.3 \\ 0 & 0.2 & 0.8 \end{pmatrix}$$

The probability of death is 0.05. Making death the fourth state, we multiply our 3×3 matrix by 0.95 and put 0.05 in the fourth column to represent the probability of transition to the death state to obtain the following transition probability matrix:

$$\begin{pmatrix} 0.57 & 0.38 & 0 & 0.05 \\ 0.19 & 0.475 & 0.285 & 0.05 \\ 0 & 0.19 & 0.76 & 0.05 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

With this transition matrix, we can compute the state vector for each year. At the beginning of the first year, the system is in state 1. At the beginning of the second year, the state vector is $(0.57 \ 0.38 \ 0 \ 0.05)$. At the beginning of the third year, the state vector is

$$(0.57 \ 0.38 \ 0 \ 0.05) \begin{pmatrix} 0.57 & 0.38 & 0 & 0.05 \\ 0.19 & 0.475 & 0.285 & 0.05 \\ 0 & 0.19 & 0.76 & 0.05 \\ 0 & 0 & 0 & 1 \end{pmatrix} = (0.3971 \ 0.3971 \ 0.1083 \ 0.0975)$$

Now we compute expected present value of losses. In each year, we multiply the probability of each start-of-year state by 0.95, since only survivors result in paid losses, and by 100, 300, or 1000 for states 1, 2, 3 respectively, and discount for the number of years at 6%. In year 1, we get $100(0.95)/1.06 = 89.62$. In year 2, we get

$$\frac{(0.57(100) + 0.38(300))(0.95)}{1.06^2} = 144.58$$

In year 3, we get

$$\frac{(0.3971(100) + 0.3971(300) + 0.1083(1000))(0.95)}{1.06^3} = 213.08$$

The expected present value of losses over a three year period is $89.62 + 144.58 + 213.08 = \boxed{447.28}$.

[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 $\ddot{a}_{x+\frac{k+1}{12}:n-\frac{k+1}{12}}^{(12)\overline{11}}$.

[2/16/2020] On page 881, in Example 47B, change the first answer from 110,800 to 104,800.

[2/20/2020] On page 884, on the third line, put the subscript x on \bar{A}^{ij} : \bar{A}_x^{ij} .

[6/2/2020] On page 884, 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 884, 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 884, 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 885, on the third line, change \bar{a}_{x+10}^{01} to \bar{a}_{x+10}^{10} .

[9/21/2019] On page 885, on the third line of Example 47E, change “year death” to “year of death”.

[9/21/2019] On page 886, on the second line after “If we assume the death benefit is paid...”, the left side of the equation is missing $1 + i$ and should be ${}_tV^{(1)}(1 + i)$.

[2/23/2020] On page 886, four lines from the bottom, change $p_{x+2}^{(13)}$ to p_{x+2}^{13} .

[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;”.

[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 897, in exercise 47.12, on the fourth line, add “if alive at that time” after “subsequent years”.

[6/5/2020] On page 897, in exercise 47.13, 2 lines from the end, delete “of”.

[6/3/2020] On page 904, in the solution to exercise 47.2, on the fifth line, change $e^{-0.0105t}$ to $e^{-0.105t}$.

[2/25/2020] On page 904, in the solution to exercise 47.2, on the last line, change $A_1 + A_2$ to $\frac{50,000(A_1 + A_2)}{8.815557}$.

[9/21/2019] On page 904, in the solution to exercise 47.3, on the first line, a 36,500 is missing from the left side of the equation and 796.58 should be 756.58; the equation should read $1.05^{-1/2}(36,500)\ddot{a}_{45:20}^{01} = 1.05^{-1/2}(36,500)(0.02124) = 756.58$. On the second line, change $\ddot{a}_{45:20}^{00} + \ddot{a}_{45:20}^{01}$ to $\ddot{a}_{45:20}^{00} + \ddot{a}_{45:20}^{01}$.

[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

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

[6/5/2020] On page 907, 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 919, two lines below equation (48.6), change “ t^{th} year” to “ k^{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 974, 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 995, 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 1004, 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.

[5/24/2019] On page 1030, in the solution to exercise 53.17, on the second line, delete the first left parenthesis in the first exponent.

[7/21/2020] On page 1073, 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 1105, in exercise 58.16(ii), change $i = 0.05$ to $\mu = 0.05$.
- [2/9/2020] On page 1121, in the solution to exercise 59.2, on the first line, change “(il) and (iii)” to “(i) and (ii)”.
- [2/9/2020] On page 1126, on the second line under “Non-independent lives”, add a period after the second integral before “For”.
- [2/10/2020] On page 1132, in exercise 60.6, on the second line, change “annual” to “Annual”.
- [7/22/2020] On page 1155, in the solution to exercise 60.39, on the first line, change ${}_{10|10}q_{30:40}$ to ${}_{10|10}q_{\overline{30:40}}$.
- [2/13/2020] On page 1158, in the solution to exercise 60.48, on the last line, change $E[X]$ to $E[Z]$.
- [10/8/2019] On page 1239, on the fourth line, change “mortality stdy” to “mortality study”.
- [10/8/2019] On page 1277, change the summation index in equation (68.1) to “ $j \mid y_j \leq t$ ”.
- [7/22/2020] On page 1294, in the solution to exercise 68.25, on the first line, replace “eq:VarSnextrap” with “(68.6)”.
- [7/22/2020] On page 1299, on line 5 of the second paragraph, change “survival survivals” to “survival probabilities”.
- [10/8/2019] On page 1300, four lines below the table, change “(64-10,67-7,s)” to “(64-10,67-2,s)”.
- [3/7/2020] On page 1327, 3 lines above Section 70.1, delete one of the two “benefit” s.
- [3/8/2020] On page 1329, on the first line, add “to” before “estimate”.
- [9/10/2019] On page 1331, one line above Example 70G, change “ $d_x^{(j)}$ -type” to “ $d_x^{(j)}$ -type”.
- [3/9/2020] On page 1331, 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 1333, on the fifth line, change 17 to 27.
- [9/26/2019] On page 1346, replace the solution to exercise 70.13 with

The number of lives leaving the job in between 2 and 4 years is $l_{42}^{(\tau)} - l_{44}^{(\tau)} = 152,631.0 - 137,656.1 = 14,974.9$. Of those, $i_{42} + i_{43} = 148.8 + 141.3 = 290.1$ leave due to disability. The quotient is $290.1/14,974.9 =$
0.019372.

- [7/22/2020] On page 1347, 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 1352, on the fourth line of the solution to Example 71C, change 94.020.3 to 94.579.7.
- [3/21/2020] On page 1352, two lines after the displayed line ending with the highlighted answer 3116.27, change 1.22194 to 2.66952.
- [10/6/2019] On page 1353, in Example 71D(vi), change “for each year before age 65” to “for each year or fraction of a year before age 65”.
- [10/12/2019] On page 1355, in both figures, change “Age” to “Service”.
- [7/6/2020] On page 1356, on the second line after Table 71.1, delete “to” between “may” and “use”.
- [7/22/2020] On page 1357, 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 1358, 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 1362, in the solution to exercise 71.2, on the first line, change “calculating” to “calculated”.
- [3/23/2020] On page 1364, in the solution to exercise 71.13, on the fourth line, change “6%” to “5%”.
- [3/24/2020] On page 1367, one line after equation (72.1), change $a_B(x, t)$ to $\ddot{a}_B(x, t)$.
- [9/10/2019] On page 1368, in equations (72.4) and (72.5), change the summation index from i to t : $\sum_{t=0}^{65-x}$.
- [3/24/2020] On page 1368, two lines below equation (72.4), change $(1 + (i^*)^t)$ to $(1 + i^*)^t$.
- [9/10/2019] On page 1371, on the line below equation (72.3), add a -1 :

$$\text{where } i^* = \frac{1+i}{c(1+j)} - 1.$$

In equations (72.4) and (72.5), change the summation index from i to t : $\sum_{t=0}^{65-x}$

- [7/9/2020] On page 1375, 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 1379, on the last line of the fourth paragraph, change “higher of lower” to “higher or lower”.

[9/10/2019] On page 1380, one line above Example 70G, change “ $d_x^{(j)}$ -type” to “ $d_x^{(j)}$ -type”.

[3/28/2020] On page 1383, on the second line of the page, change “year t ” with “year k ”.

[9/10/2019] On page 1385, on the second line below the heading **DPP**, change = to \geq :

$$\sum_{k=0}^m \Pi_k v^k \geq 0$$

[3/31/2020] On page 1386, two lines from the bottom, change “the each” to “each” (delete “the”).

[4/6/2020] On page 1401, in the solution to exercise 73.20, on the fourth line, change -80 to 80 .

[4/15/2019] On page 1406, in Table 74.1, the expense gain formula should split withdrawal settlement expenses ($E_k^{(w)}$) and death settlement expenses ($E_k^{(d)}$):

$$(e_k^* - e_k')(1+i) + q_{x+k-1}^{(d)}(E_k^{(d)*} - E_k^{(d)}) + q_{x+k-1}^{(w)}(E_k^{(w)*} - E_k^{(w)})$$

[9/10/2019] On page 1412, in the solution to exercise 74.8, 3 lines from the end, change $(15 - 10)$ to $(10 - 15)$.

[7/22/2020] On page 1417, in exercise 75.8, change $0.002k$ to $0.002j$.

[4/5/2019] On page 1470, in question 5, add to statement (ii): $q_{50} = 0.00592$.

[4/14/2019] On page 1482, in question 6(c), change $100,300$ to $116,500$.

[7/22/2020] On page 1489, in question 2(c), change 26 to 16 .

[7/22/2020] On page 1507, in question 20(i), change “years” to “year”.

[2/27/2019] On page 1509, on the line before question 5(c), change 6% to 5% . On the first line of question 5(c), change 270 to 410 .

[7/22/2020] On page 1518, in question 4(b), on the third line, change “ 1.3 ” to “ 1.2 ”.

[7/22/2020] On page 1519, in question 6(b), delete “, using $i=0.06$ ”. In question 6(f), change “It” to “it”.

[7/19/2020] On page 1526, in question B1 (iii), change $10,000,000$ to $100,000$.

[10/31/2019] On page 1537, in question 6, on the ninth line, change “to not” to “do not”.

[7/22/2020] On page 1538, in question 4(e), change “(c)” to “(d)”.

[10/6/2019] On page 1565, in question 20(iv), change the last sentence to “The benefit is reduced by 8 ”.

[8/30/2019] On page 1566, in question 2(b)(ii), change “healthy” to “sick”.

[7/22/2020] On page 1568, in the schematic diagram, change “ 4 ” in the Dead box to “ 3 ”.

[7/22/2020] On page 1573, in question 9, change the headings in the table from d_j, x_j, u_j to n_j, d_j, w_j respectively.

[10/19/2019] On page 1590, in the solution to question 3(b), on the third line, change $100\ddot{a}_{60}$ to $100\bar{a}_{60}$.

[2/3/2019] On page 1592, in the solution to question 4(e), 4 lines from the end, change 95.2510 to 113.7567 . Change the third line from the end to

Multiplying by i/δ , we get $1.0248(113.7567) = \boxed{116.58}$.

[2/6/2019] On page 1592, in the solution to question 5(b), change the final answer to 0.005215 .

[2/13/2019] On page 1593, in the solution to question 6(b), change the final answer to $35,378$.

[4/14/2019] On page 1599, in the solution to question 1(e), change the second line to

$$(2600 - 556)(1.05) - 0.00763(100,000) - (1 - 0.00763)(-1822.83) = \boxed{3192.12}$$

[7/22/2020] On page 1617, on the last line of the page, change “MLC” to “LTAM”.

[7/22/2020] On page 1623, 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 1635, at the end of the solution to question 2(a), delete the stray “S”.

[7/22/2020] On page 1636, 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 1637, in the solution to question 4(c), on the first line, change 0.01054575 to 0.010882986. On the last line, remove the framed shaded box from 9.9409 and add the following line after that line:

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

[10/12/2019] On page 1650, in the solution to question 2, 2 lines from the end of the page, insert “Var” before $(S_n(y_k))$.

[4/24/2019] On page 1652, in the solution to question 6(e), replace the last 3 lines with

$$\begin{aligned} 116,545(1.05^2 0) + 4,621,746k &= 0.5(210,685)(10.65) \\ 309,229 + 4,621,746k &= 1,121,897 \end{aligned}$$

Solving for k , we get $\boxed{0.17584}$.

[10/12/2019] On page 1652, the solution to question 8 has several errors. Replace everything after the third line with:

$$\begin{aligned} {}_{19}E_{51} &= \frac{{}_{20}E_{50}(1.05)}{1 - q_{50}} = \frac{0.34824(1.05)}{1 - 0.001331} = 0.36609 \\ {}_{19}\ddot{a}_{51} &= {}_{19}E_{51} \ddot{a}_{70} = (0.36609)(12.0083) = 4.3962 \\ \pi &= \frac{A_{51}}{\ddot{a}_{51} + {}_{19}\ddot{a}_{51}} = \frac{197.80}{16.8461 + 4.3962} = 9.3116 \end{aligned}$$

Now we calculate the reserve prospectively.

$$\begin{aligned} {}_{10}\ddot{a}_{60} &= {}_{10}E_{60} \ddot{a}_{70} \\ &= (0.57864)(12.0083) = 6.9485 \\ {}_{10}V &= 1000A_{60} - \pi(\ddot{a}_{60} + {}_{10}\ddot{a}_{60}) \\ &= 290.28 - 9.3116(14.9041 + 6.9485) = \boxed{86.7970} \end{aligned}$$

[7/22/2020] On page 1661, 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 1668, 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 1668–1669, 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, μ 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 1671, in the solution to question 5(a) and 5(b), change 3195.1 to 319.51 in the two places it appears.

[10/31/2019] On page 1674, in the solution to question 2, on the fifth and seventh lines, replace 23,748 with 24,798.

[7/22/2020] On page 1677, in the solution to question 14, replace the answer key **(D)** with **(C)**. Also correct the answer key on page 1674.

[7/22/2020] On page 1678, in the solution to question 17, replace the answer key **(E)** with **(B)**. Also correct the answer key on page 1674.

[10/31/2019] On page 1683, in the solution to question 6(b), change the final answer from 175,194.6 to 36,584.02.

[7/22/2020] On page 1695, in the solution to question 6:

- In part (a), on the first displayed line, change 4,354.70 to 4,152.44. On the second displayed line, change 17,295.00 to 16,491.72. Change the final answer from 21,649.70 to 20,644.16.
- 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 1699, in the solution to question 13, on the second and seventh lines, change 0.37135 to 0.36135.

[7/23/2020] On page 1701, in the solution to question 1(a), change the final answer to 65,685.58.

[7/23/2020] On page 1704, in the solution to question 4(b), on the third line, change $0.02(64.9)$ to $0.02(29.9)$.

In the solution to question 4(c), change the last 3 lines to

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

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

[7/23/1970] On page 1708, in the solution to question 4, on the second-to-last line, change e_{68} to e_{68}^2 .

[7/23/2020] On page 1709, in the solution to question 9, change the answer key to (A). Also change the answer key on page 1707 accordingly.

[7/23/2020] On page 1716, in the solution to question 6(c), on the second-to-last line, change 329.72 to 2329.72.

[7/23/2020] On page 1724, 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 1728, 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 1843, in the solution to question 2(b), change ${}_{51}\bar{a}_x$ to $1000{}_{51}\bar{a}_x$.

[4/18/2020] On page 1843, in the solution to question 2(c)(ii), on the first and fourth lines, change $v^5\bar{a}_{x+5}$ to $1000v^5\bar{a}_{x+5}$.