Errata and Updates for ASM Exam MLC (Eleventh Edition) Sorted by Page

[12/17/2011] On page 2, two lines above equation (1.2), replace "the next lesson" with "Section 1.3". On the next line, replace "formula (1.2)" with "the first of the three formulas above".

[12/17/2011] On page 2, 2 lines from the bottom of the page, replace p in $x_1+(x_2-x_1)p$ with q.

[12/17/2011] On page 6, on the first line of Section 1.5, $\Pr(B\neq 0)$ should be $\Pr(B)\neq 0$.

[12/17/2011] On page 20, in (iii) on line 14, change the function to $S_x(t)=\begin{cases}1-0.01t & t\le 100\\ 0 & t>100\end{cases}$

[12/17/2011] On page 23, 2 lines from the bottom of the page, replace the formula at the end of the line with ${}_{u|t}q_x = (l_{x+u}-l_{x+t+u})/l_x$.

[12/17/2011] On page 25, on the second line of Section 2.4, add "on" after "expect". One line after the first displayed line in that section, change R_x to R_x^s.

[12/17/2011] On page 27, in the second-to-last formula in Table 2.1, change the numerator ${}_u d_x$ to ${}_u d_{x+t}$.

[12/12/2011] On page 32, in the solution to exercise 2.2, at the beginning of the first displayed line, § should be S.

[12/20/2011] On page 34, in the solution to exercise 2.14, the second sentence is cut off and should read

It's the usual CAS type of humor—it's not that the answer cannot be determined from the given information (almost never the right answer choice), rather there is too much information provided.

[12/20/2011] On page 35, in the solution to exercise 2.19, on the first line, change l_{x-1} to l_{x+1}.

[12/20/2011] On page 40, in the answer to Example 3B, on the second and third lines (once apiece), change $e^{-0.01}$ to $e^{-0.1}$.

[12/20/2011] On page 43, on the first line of Table 3.1, change the denominator $s_X(x)$ to $S_X(x)$.

[1/24/2012] On page 52, in the solution to exercise 3.7, change the 4th and 5th lines to

Differentiating and negating,

$$\mu_x=\frac{1}{120-x}-\frac{1}{x+150}=-\frac{1}{x-120}-\frac{1}{x+150}$$

[12/24/2011] On page 71, in question 4.10, at the end of the first line, change 100 to 105.

[2/6/2012] On page 74, the final answer to exercise 4.5 should be 0.007566.

[12/19/2011] On page 82, 4 lines from the bottom of the page, change $\mathring{e}_{x:\overline{n}|}$ to $\mathring{e}_{u:\overline{n}|}$.

[12/31/2011] On page 94, delete exercise 5.33, which is a duplicate of exercise 5.32.

[2/22/2012] On page 94, in exercise 5.35, change (i) and (ii to:

(i) $\mathring{e}_{30:\overline{40}|}=27.692$

(ii) $S_0(x)=1-\dfrac{t}{\omega}, \qquad 0\le t\le\omega$

[12/31/2011] On page 95, in exercise 5.36(ii), change "fore" to "force".

[12/31/2011] On pages 105–106, in the solution to exercise 5.38, on the last line of page 105 and the second line of page 106, the square should be inside the outer parenthesis: $\int_{30}^{80}\left(1-(0.01t)^2\right)\mathrm{d}t$.

[12/31/2011] On page 106, on the first line of the solution to exercise 5.39, put a period after p_{70} and remove the period after $[0,2]$.

[1/30/2012] On page 116, in the solution to exercise 6.1, on lines 6–9, remove the negative signs before B and the negative signs before ln. Then these lines will read

$$\exp\left(\frac{B(1-c^{40})}{\ln c}\right)=0.9$$
$$\frac{B(1-c^{40})}{\ln c}=\ln 0.9$$
$$\exp\left(\frac{B(1-c^{80})}{\ln c}\right)=0.3$$
$$\frac{B(1-c^{80})}{\ln c}=\ln 0.3$$

[1/4/2012] On page 120, in the solution to exercise 6.19, 2 lines from the bottom of the page, change "the integral is equal" to "making the integral equal". On page 121, on the first line of the page, change ${}_{10}p_{50}$ to ${}_{10}p_{40}$.

[1/7/2012] On page 130, in Table 7.1, on the line for ${}_sp_x\,\mu_{x+s}$, the formula for constant force of mortality should be $-(p_x^s)(\ln p_x)$.

[1/4/2012] On page 134, delete exercise 7.22 which duplicates the previous exercise.

[1/7/2012] On page 135, in exercise 7.28, on the last line, put a period after 97.5.

[1/29/2012] On page 136, in exercise 7.30(i), change 809 to 80.

[1/15/2012] On page 144, in the solution to exercise 7.30, on the 5th line, replace 0.299647 with 0.296647. On the 3rd and 4th lines from the end, replace $(80-x)^{0.5}$ with $(80-x)^{-0.5}$. On the last line, replace $0.299647-0.299615$ with $0.296647-0.296615$.

[1/22/2012] On page 161, in the solution to exercise 8.18, on the first displayed line, put $1-$ before $\frac{900}{1000}$.

[1/15/2012] On page 163, in the solution to exercise 8.25, on the first line, [30] should be a subscript. At the end of the second line, 40 should be a subscript. Change the fourth line to:

value of the integrand at the middle of the integration interval ($t=5$) times 10.

[1/24/2012] On page 179, in exercise 9.12, $\left(\frac{1}{1.04}\right)_x^T$ should be $\left(\frac{1}{1.04}\right)^{T_x}$.

[1/15/2012] On page 184, in exercise 9.33, on the third line, replace "od" with "of".

[1/30/2012] On page 184, in exercise 9.35, on the first and last lines of the question, replace S (once apiece) with b.

[1/15/2012] On page 193, on the first line of the solution to exercise 9.37, replace (12∞) with $(12,\infty)$.

[1/23/2012] On page 193, in the solution to Quiz 9-1, on the second displayed line, replace $A_{30:\overline{10|}}$ with $A_{30:\overline{10|}}^{\frac{1}{}}$.

[1/15/2012] On page 199, in the answer to Example 10E, delete the second paragraph, which begins with "Let X be a Bernoulli ...".

[1/30/2012] On page 202, in exercise 10.4, answer choice (B) should be 375.

[1/5/2012] On page 214, the solution to exercise 10.25 is incorrect. The correct solution is

Since X and Z are mutually exclusive and $Y = X + Z$,

$$\begin{aligned}
\mathbf{E}[Z] &= \mathbf{E}[Y] - \mathbf{E}[X] = 0.65 - 0.04 = 0.61 \\
\text{Var}(Y) &= \text{Var}(X) + \text{Var}(Z) + 2\,\text{Cov}(X,Z) = \text{Var}(X) + \text{Var}(Z) - 2\,\mathbf{E}[X]\,\mathbf{E}[Z] \\
0.08 &= 0.12 + \text{Var}(Z) - 2(0.04)(0.61) \\
\text{Var}(Z) &= 0.08 + 2(0.04)(0.61) - 0.12 = \boxed{\mathbf{0.0088}}
\end{aligned}$$

[1/30/2012] On page 250, in Example 12C, on the second line, replace "less than" with "minus".

[1/28/2012] On page 253, one line above Section 12.3, change the numerator of the fraction to $13.86 + 27.73 - 25$.

[12/27/2011] On page 267, in the solution to exercise 12.21, on the third displayed line, remove the negative sign at the start of the line.

[2/1/2012] On page 295, in the solution to exercise 13.29, on the 5th line, change $p_{40}q_{40}$ to $p_{40}\,q_{41}$ and change ${}_9p_{40\,9|}q_{41}$ to $p_{40\,9|}q_{41}$.

[2/15/2012] On page 354, in the solution to exercise 16.37, on the 5th line from the end, put a 12 before $\left(1 - \dfrac{1}{1.05^{1/12}}\right)$.

On the next line, $\ddot{a}_{65}^{(12)}$ should be $\ddot{a}_{65:\overline{20|}}^{(12)}$. Also, change 10.8857 to 10.4206. On the last line, change 10.8857 to 10.4206 and change 129.84 to 124.27.

[2/15/2012] On page 360, on the second line of the first paragraph, insert "for" after "formula (17.1)".

[1/23/2012] On page 363, in Table 17.1, in formula (17.12), the first denominator should be d rather than d^2.

[2/8/2012] On page 367, in exercise 17.21, on the last line, $\bar{A}_{\overline{T_x|}}$ should be $\bar{a}_{\overline{T_x|}}$.

[1/24/2012] On page 372, in exercise 17.40, on the second line, change b to S. (*Actuarial Mathematics for Life Contingent Risks* uses S for the face amount, whereas the exam will use b. In this question, S is used in the solution repeatedly, so it is easier to change the only b to an S than to change all the S's to b's.)

[2/2/2012] On page 397, in exercise 18.24, answer choice (E) should be 0.79.

[2/19/2012] On page 405, the solution to Example 19A is incorrectly labeled "Example 19B". in addition, the last four lines of the solution should be changed to:

Let a be the expected present value. The first payment is 1000, not 1000(1.04), so we must divide the sum by 1.04.

$$\begin{aligned}
a &= \frac{1000}{1.04}\sum_{k=1}^{\infty} e^{-0.02k}\,1.00961538^{-k} \\
&= \frac{1000}{1.04}\sum_{k=1}^{\infty} e^{-(0.02+\ln 1.00961538)k} = \sum_{k=1}^{\infty} e^{-0.029569k} \\
&= \frac{1000}{1.04}\left(\frac{e^{-0.029569}}{1-e^{-0.029569}}\right) = \boxed{\mathbf{32039.57}}
\end{aligned}$$

[2/18/2012] On page 423, on the last displayed line of the answer to Example 20B, change 16.0599 to 12.2758.

[2/18/2012] On page 423, on the third line from the bottom, change "1 more" to "1 less".

[1/3/2012] On page 424, in Table 20.1, in formula (20.5), the second denominator should be $12m^2$.

[2/19/2012] On page 424, in Table 20.1, in formula (20.7), change the $\overline{m}|$'s to $\overline{n}|$'s:

$$\ddot{a}^{(m)}_{x:\overline{n}|} \approx \ddot{a}_{x:\overline{n}|} \cdots$$

[2/13/2012] On page 428, in exercise 20.18, on the third line, change $\ddot{a}^{(12)}_{80} = 8.16715$ to $\ddot{a}^{(4)}_{80} = 8.16715$.

[1/22/2012] On page 436, 2 lines above equation (21.1), $\ddot{a}_x$ should be $\bar{a}_x$.

[1/22/2012] On page 437, on the first line, $\ddot{a}_x$ should be $\bar{a}_x$.

[1/22/2012] On page 437, on the line after the fourth displayed line (the formula for an n-year deferred insurance) add

if premiums are payable only during the deferral period, and

$$P = \frac{{}_{n|}\bar{A}x}{\bar{a}_x}$$

if premiums are payable for life.

[2/18/2012] On page 438, in the answer to Example 21D, on the first line, change the equation to $\bar{A}_{50} = P\bar{a}_{50:\overline{20}|}$.

[1/5/2012] On page 438, in the answer to Example 21D, replace the last 3 lines with

$$\bar{A}_{50} = \frac{\mu}{\mu+\delta} = 0.2$$
$$\bar{a}_{50:\overline{20}|} = \frac{1-e^{-20(\mu+\delta)}}{\mu+\delta} = \frac{0.632121}{0.05} = 12.6424$$
$$P = \frac{0.2}{12.6424} = \boxed{\mathbf{0.01582}}$$

[2/6/2012] On page 483, in exercise 23.29(vi), L_* should be L^*.

[2/18/2012] On page 502, a pair of parentheses is missing on the last line of the answer to Example‘25A, which should read

$$L^g_0 = 1000(0.96^{31}) + \underbrace{0.45(22)+96}_{105.9} + \underbrace{\big(0.05(22)+4-22\big)}_{-16.9}(17.94742) = \boxed{\mathbf{84.692}}$$

[2/6/2012] On page 508, in exercise 25.11(iii), change the expression at the end of the line to $10{,}000(1.03^{K_x})$.

[12/30/2011] On page 513, in the solution to exercise 25.11, on the third line from the end, change $PG0.5$ to $G(0.5$.

[2/21/2012] On page 515, in the solution to Quiz 25-1, on the fifth line, change 45 in the subscript to x.

[1/27/2012] On page 561, in exercise 28.8, replace (i) with $l_x = 5(120-x)$, $x < 120$.

[2/9/2012] On page 563, in the solution to exercise 28.2, on the 7th, 12th, and second to last lines, change T_{40} to T_{35}.

[1/27/2012] On page 566, in the solution to exercise 28.9, on the last line, replace $33/80 = \boxed{\mathbf{0.4125}}$ with $1 - 33/80 = \boxed{\mathbf{0.5875}}$.

[2/22/2012] On page 570, on the first line of the answer to Example 29B, change $\delta - 0.04$ to $\delta = 0.04$.

[12/31/2011] On page 573, in the solution to exercise 29.1, the final answer should be 16.45.

[1/24/2012] On page 574, in the solution to exercise 29.7, on the third line, change "e" after the period to "The". Replace the last line of the solution with:

The expected present value of the insurance is $1-d\ddot{a}_x = 1-(0.05/1.05)\ddot{a}_x$. We conclude that $b = \boxed{\mathbf{1}}$ and $c = -0.05/1.05 = \boxed{\mathbf{-0.047619}}$.

[1/30/2012] On page 578, on the first line of Quiz 30-2, change "fully discrete" to "semi-continuous".

[2/12/2012] On page 582, in exercise 30.8(i), change the statement to $q_{x+k} = 0.1$ for $k = 0, 1, 2, \ldots 15$. In 30.8(iii), change T to K_x.

[2/9/2012] On page 586, in exercise 30.22(iv), k_{40} should be K_{40}.

[12/31/2011] On page 601, in exercise 31.7(iii), $A_{45} - 0.15$ should be $A_{45} = 0.15$.

[2/12/2012] On page 630, in question 33.6, on the second line from the end of the question, change i from 0.025 to 0.03.

[2/11/2012] On page 635, in question 33.22, on the fourth line, add "at time 30" after "benefit reserve".

[2/21/2012] On page 655, in exercise 34.16, add after "premium": "for 1000 of endowment insurance".

[2/14/2012] On page 676, in exercise 35.19(iii), change 1658 to 16.58.

[1/1/2012] On page 706, 3 lines above Example 36B, change "on assumption" to "one assumption".

[1/1/2012] On page 707, the first two lines are unclear and use the word "profit" in the sense of "gain". Here is a rewrite of them:

As a check, add up the three gains by source and compare the sum against total gain. The sum of the three gains is $5.2 - 21.26 + 7.73 = -8.33$. Total gain is the excess of ending funds over the sum of death benefits plus reserves—in other words,

[1/1/2012] On page 709, in the third displayed equation in Section 36.4, change P_t to G_t.

[2/13/2012] On page 714, in Table 36.1, on the second line, replace "profit" with "gain". On the sixth line, in the expense component, replace $E_k^* - E_k'$ with $q_{x+k-1}(E_k^* - E_k')$. On the next line, in the mortality component, replace E_k with E_k'. The next two lines can be deleted since they duplicate the second and third lines.

[2/13/2012] On pages 716–717, in exercises 36.7–36.11, the word "profit" should be replaced with "gain" wherever it appears (and "profits" with "gains"). Make these changes in the solutions to these exercises as well. The only exceptions are in the solution to exercise 36.11 on page 729, where the word "profit" should not be changed on the first line, fifth line, and seventh line. It should be changed on the second and last lines.

[12/16/2011] On page 719, in exercise 36.22, delete "with a step of 0.1" that is after "Thiele's differential equation".

[1/3/2012] On page 722, in exercise 36.34(v), change $P_{15:\overline{29|}}$ to $P_{16:\overline{29|}}$.

[1/3/2012] On page 725, in exercise 36.46, change (iii) to $1000P_x = 9.55$.

[2/5/2012] On page 749, in exercise 37.7(i), replace p_{x+k}^{01} with p_{x+k}^{00} and p_{x+k}^{02} with p_{x+k}^{01}.

[2/13/2012] On page 749, in exercise 37.8(ii), in the second and third equations, change + to −: $0.3 - \dfrac{0.1}{k+1}$ and $0.4 - \frac{0.2}{k+1}$.

[2/22/2012] On page 752, replace the solution to exercise 37.8 with

This question numbers the states starting at 1 instead of at 0.

To be preferred at the start of year 4, either she has to transition to preferred in year 2 and again in year 3, or she has to transition to standard in year 2 and then preferred in year 3. Let's sum up the two

probabilities.

$$p^{11}_{[x]+1}\,p^{11}_{[x]+2}=\left(0.7+\frac{0.1}{2}\right)\left(0.7+\frac{0.1}{3}\right)=0.531667$$
$$p^{12}_{[x]+1}\,p^{21}_{[x]+2}=\left(0.3-\frac{0.1}{2}\right)\left(0.4-\frac{0.2}{3}\right)=0.093333$$

The answer is ${}_2p^{11}_{[x]+2}=0.55+0.083333=\boxed{\mathbf{0.633}}$. **(C)**

[1/5/2012] On page 764, in exercise 38.17, on lines 5–9, replace the five "(1.enumno)"'s with 1, 2, 3, 4, and 5 respectively. Three lines below that list, replace $\mu^{21}=0.2$ with $\mu^{21}=0.5$.

[1/5/2012] On page 765, in the solution to exercise 38.1, on the last line, replace "begin" with "being".

[12/19/2011] On page 776, in Example 39H, on the two displayed lines, remove the parentheses around the two superscripts 12.

[2/21/2012] On page 780, one line below formula (39.5), change $t=h$ to $t-h$.

[1/7/2012] On page 786, in exercise 38.22, in (iv), delete "is paid". In (v), change "yea" to "year".

[1/10/2012] On page 792, the solution to exercise 39.17 is incorrect. The correct solution is

First we calculate the annuity of 1 per year for the premium. This is a continuous annuity of 1 per year while in state 0. It can be expressed as a 10-year temporary annuity followed by a 10-year deferred whole life annuity, and both of these can be evaluated by the usual single-decrement formulas for constant forces, using the constant force of total decrement, which is $\mu^{01}+\mu^{02}=0.03+0.02=0.05$ for the first ten years and 0.08 afterwards.

$$\bar{a}^{(00)}=\frac{1-e^{-10(0.05+0.05)}}{0.05+0.05}+e^{-10(0.05+0.05)}\left(\frac{1}{0.08+0.05}\right)=9.151047$$

To calculate the annuity while disabled, we first need to calculate ${}_tp^{01}_{40}$. The probability depends on the time of disablement. We will use ${}_tp^{01a}_{40}$ to indicate the probability of state 1 at time t assuming disablement occurred before time 10 ($0<t<\infty$) and ${}_tp^{01b}_{40}$ to indicate the probability of state 1 at time t if disablement occurred after time 10 ($10<t<\infty$). If disablement occurs before time 10 and $t\le 10$, it is a constant force situation, and we can use equation (38.4):

$$\begin{aligned}{}_tp^{01a}_{40}&=\mu^{01}e^{-\mu^{12}t}\left(\frac{1-e^{-(\mu^{01}+\mu^{02}-\mu^{12})t}}{\mu^{01}+\mu^{02}-\mu^{12}}\right)\\&=\frac{0.03e^{-0.15t}}{0.03+0.02-0.15}(1-e^{-(0.03+0.02-0.15)t})\\&=0.3(e^{-0.05t}-e^{-0.15t})\end{aligned}$$

If $t>10$, then

$$\begin{aligned}{}_tp^{01a}_{40}&=\int_0^{10}e^{-0.05s}(0.03)e^{-0.15(t-s)}\mathrm{d}s\\&=0.03e^{-0.15t}\int_0^{10}e^{0.1s}\mathrm{d}s\\&=0.3e^{-0.15t}(e-1)\end{aligned}$$

If disablement occurs after time 10, then for $t > 10$:

$$\begin{aligned}
{}_tp_{40}^{01b} &= \int_{10}^{t} {}_sp_{40}^{00}\mu_{40+s}^{01}\,{}_{t-s}p_{40+s}^{11}\,\mathrm{d}s \\
&= \int_{10}^{t} e^{-0.05(10)-0.08(s-10)}(0.06)e^{-0.15(t-s)}\mathrm{d}s \\
&= 0.06e^{0.3}e^{-0.15t}\int_{10}^{t} e^{0.07s}\,\mathrm{d}s \\
&= 0.06e^{0.3-0.15t}\left(\frac{e^{0.07t}-e^{0.7}}{0.07}\right) \\
&= \frac{6}{7}\left(e^{0.3-0.08t}-e^{1-0.15t}\right)
\end{aligned}$$

Now we calculate the EPV of 1 per year while disabled. We need to calculate $\int_0^\infty v^t\,{}_tp_{40}^{01}\,\mathrm{d}t$, and ${}_tp_{40}^{01}$ is the sum of the probabilities ${}_tp_{40}^{01a}$ and ${}_tp_{40}^{01b}$, so we will integrate $e^{-0.05t}$ over the three integrals developed above.

$$\begin{aligned}
\int_0^{10} e^{-0.05t}\,{}_tp_{40}^{01a}\,\mathrm{d}t &= 0.3\int_0^{10}(e^{-0.1t}-e^{-0.2t})\mathrm{d}t \\
&= 0.3\left(\frac{1-e^{-1}}{0.1}-\frac{1-e^{-2}}{0.2}\right) = 0.599365 \\
\int_{10}^{\infty} e^{-0.05t}\,{}_tp_{40}^{01a}\,\mathrm{d}t &= 0.3(e-1)\int_{10}^{\infty} e^{-0.2t}\mathrm{d}t \\
&= 0.3(e-1)\frac{e^{-2}}{0.2} = 0.348816 \\
\int_{10}^{\infty} e^{-0.05t}\,{}_tp_{40}^{01b}\,\mathrm{d}t &= \frac{6}{7}e^{0.3}\int_{10}^{\infty}\left(e^{-0.13t}-e^{-0.7-0.2t}\right)\mathrm{d}t \\
&= \frac{6}{7}e^{0.3}\left(\frac{e^{-1.3}}{0.13}-\frac{e^{-1.3}}{0.2}\right) = 0.848953
\end{aligned}$$

The disability annuity of 1000 per year while disabled has expected present value 1000(0.599365+0.348816+0.848953) = 1797.133. The benefit premium is 1797.133/9.151047 = **196.39**.

[1/7/2012] On page 810, in exercise 40.27(i), on the line for $x = 40$, replace 29 with 20.

[1/7/2012] On page 813, in exercise 40.35(iii), change 0.96 to 0.95.

[2/13/2012] On page 850, in exercise 42.3(iii), change q_{30}^2 to $q_{30}^{\prime(2)}$.

[1/10/2012] On page 901, in exercise 45.35(i), $q_{62} - 0.02$ should be $q_{62} = 0.02$.

[2/11/2012] On page 906, in the solution to exercise 45.20, on the second to last line, replace ${}_tq_x^{(d)}\,{}_tq_x^{(r)}$ with ${}_tp_x^{(d)}\,{}_tp_x^{(r)}$.

[1/10/2012] On page 959, in exercise 48.19, delete statement (i).

[1/24/2012] On page 975, in exercise 49.14, delete the answer choices.

[1/11/2012] On page 978, in the solution to exercise 49.6, on the displayed line, change both ω's to $\omega - x$.

[1/10/2012] On page 1001, in the solution to exercise 50.15, on the displayed line, a t is missing from the exponent of the first numerator. The first numerator should be $e^{-0.05t}\,\mathrm{d}t$.

[1/10/2012] On page 1025, in exercise 52.22(ii), change (y) to (50). In 52.22(iii), change (x) to (45).

[1/11/2012] On page 1025, in exercise 52.23(i), delete "if it occurs within 10 years". In 52.23(iv), delete "both".

[1/10/2012] On pages 1037–1038, in the solution to exercise 52.22, the μ^{ij}'s are interchanged on the first line. Due to symmetry, this does not affect the answer. However, here is a corrected and someone expanded solution:

We are given $\mu^{02}=0.02$, $\mu^{13}=0.05$, $\mu^{01}=0.015$, $\mu^{23}=0.03$,

$$
\begin{aligned}
{}_tp^{01}_{45:50} &= 0.015e^{-0.05t}\left(\frac{1-e^{0.015t}}{-0.015}\right) = e^{-0.035t}-e^{-0.05t} \\
{}_tp^{02}_{45:50} &= 0.02e^{-0.03t}\left(\frac{1-e^{-0.005t}}{0.005}\right) = 4\left(e^{-0.03t}-e^{-0.035t}\right)
\end{aligned}
$$

The single benefit premium for a unit of insurance is

$$
\begin{aligned}
\bar{A}_{\overline{45:50}} &= \int_0^\infty v^t\left({}_tp^{01}_{45:50}\mu^{13}+{}_tp^{02}_{45:50}\mu^{23}\right)\mathrm{d}t \\
&= \int_0^\infty e^{-0.04t}\Big((e^{-0.035t}-e^{-0.05t})(0.05)+(4)(e^{-0.03t}-e^{-0.035t})(0.03)\Big)\mathrm{d}t \\
&= \int_0^\infty \Big(0.05(e^{-0.075t}-e^{-0.09t})+0.12(e^{-0.07t}-e^{-0.075t})\Big)\mathrm{d}t \\
&= \frac{0.05}{0.075}-\frac{0.05}{0.09}+\frac{0.12}{0.07}-\frac{0.12}{0.075} = 0.225397
\end{aligned}
$$

An annuity of 1 per year while in states 0, 1, or 2 has single benefit premium $({}_tp^{00}_{45:50}=e^{-0.035t})$

$$
\begin{aligned}
\bar{a}_{\overline{45:50}} &= \int_0^\infty v^t\left({}_tp^{00}_{45:50}+{}_tp^{01}_{45:50}+{}_tp^{02}_{45:50}\right)\mathrm{d}t \\
&= \int_0^\infty (\underbrace{e^{-0.075t}}_{00}+\underbrace{e^{-0.075t}-e^{-0.09t}}_{01}+\underbrace{4e^{-0.07t}-4e^{-0.075t}}_{02})\mathrm{d}t \\
&= -\frac{2}{0.075}+\frac{4}{0.07}-\frac{1}{0.09} = 19.36508
\end{aligned}
$$

The annual benefit premium for 1000 is $1000(0.225397)/19.36508 = \boxed{\mathbf{11.6393}}$.

[1/10/2012] On page 1038, the solution to exercise 52.23 is incorrect. The correct solution is

Because of the constant forces, the reserve is constant. The forces of transition are $\mu^{01}=0.04$, $\mu^{02}=0.02$, $\mu^{13}=0.03$, $\mu^{23}=0.01$.

$$
\begin{aligned}
{}_tp^{01}_{xy} &= 0.04e^{-0.03t}\left(\frac{1-e^{-0.03t}}{0.03}\right) = \frac{4}{3}\left(e^{-0.03t}-e^{-0.06t}\right) \\
{}_tp^{02}_{xy} &= 0.02e^{-0.01t}\left(\frac{1-e^{-0.05t}}{0.05}\right) = 0.4(e^{-0.01t}-e^{-0.06t})
\end{aligned}
$$

The single benefit premium for a last survivor insurance of 1 is

$$\begin{aligned}\bar{A}_{\overline{xy}:\overline{10}|} &= \int_0^\infty v^t \left({}_tp_{xy}^{01}\,\mu^{13} + {}_tp_{xy}^{02}\,\mu^{23} \right) \mathrm{d}t \\ &= \int_0^\infty e^{-0.05t} \left(\frac{4}{3}(e^{-0.03t} - e^{-0.06t})(0.03) + 0.4(e^{-0.01t} - e^{-0.06t})(0.01) \right) \mathrm{d}t \\ &= \int_0^\infty \left(0.04e^{-0.08t} - 0.04e^{-0.11t} + 0.004e^{-0.06t} - 0.004e^{-0.11t} \right) \mathrm{d}t \\ &= \frac{0.04}{0.08} - \frac{0.04}{0.11} + \frac{0.004}{0.06} - \frac{0.004}{0.11} = 0.166667\end{aligned}$$

An annuity of 1 per year while (x) is alive has EPV

$$\begin{aligned}\bar{a}_x &= \int_0^\infty v^t \left({}_tp_{xy}^{00} + {}_tp_{xy}^{01} \right) \mathrm{d}t \\ &= \int_0^\infty e^{-0.05t} \left(e^{-0.06t} + \frac{4}{3}(e^{-0.03t} - e^{-0.06t}) \right) \mathrm{d}t \\ &= \int_0^\infty \left(e^{-0.11t} + \frac{4}{3}(e^{-0.08t} - e^{-0.11t}) \right) \mathrm{d}t \\ &= \frac{1}{0.11} + \frac{4}{3}\left(\frac{1}{0.08} - \frac{1}{0.11} \right) = 13.63636\end{aligned}$$

So the benefit premium is $10{,}000(0.166667)/13.63636 = 122.2222$. In state 1, the EPV of the insurance is that of any exponential single-life insurance, $b\mu/(\mu+\delta) = 10{,}000\big(0.03/(0.03+0.05)\big) = 3750$. The EPV of an annuity of 1 per year is $1/(0.03+0.05) = 12.5$. So the benefit reserve is $3750 - 12.5(122.2222) =$ **2222.22**.

[1/13/2012] On page 1098, in the solution to exercise 56.4, change the second and third lines of the page to:

$$= 0.5(\ln 0.14 - \ln 0.10) - 0.083333 = 0.084903$$

The total variance is $0.000572 + 0.084903 =$ **0.085475**.

[1/13/2012] On page 1098, in the solution to exercise 56.6, on the first displayed line at the end, change $-38.4q_{60}$ to $+38.4q_{60}$.

[1/13/2012] On page 1100, in the table at the bottom of the page, the heading on the second column should be ${}_{t-1}V$ instead of ${}_tV$.

[1/16/2012] On page 1106, on the first line of the answer to Example 57C, -0.02 should be deleted, and 0.89 should be 0.91. This affects the entire solution. The correct solution is

For the profit in state 0, $p_{x+9}^{00} = 1 - 0.03 - 0.01 - 0.05 = 0.91$. The change in reserve is

$$1250(1.055) - 0.91(1400) - 0.03(6580) = -152.65$$

The profit per survivor is

$$\mathrm{Pr}_9^{(0)} = 250(0.95)(1.055) - 152.65 - 0.01(10000) - 0.05(0.9)(1400) = -65.0875$$

In state 1 the change in reserve is

$$6400(1.055) - 0.98(6580) = 303.6$$

The profit per survivor is

$$\text{Pr}_9^{(1)} = \Big(250(0.95) - 500\Big)(1.055) + 303.6 - 0.02(10000) = -173.3375$$

Notice the inclusion in the profit of the annual disability benefit at the start of the year.

The profit per policy issued is

$$\Pi_t = 0.65(-65.0875) + 0.10(-173.3375) = \boxed{\mathbf{-59.640625}}$$

[1/14/2012] On page 1110, in exercise 57.7, the table is missing a line for 6. Add a line between 5 and 7 with 6 in the first column, 140 in the second column.

[1/14/2012] On page 1115, in the solution to exercise 57.7, the last line has an extra 0.95 factor in each numerator. The line should read:

$$\frac{140}{1.1} + \frac{135(0.97456)(0.95)}{1.1^2} + \frac{130(0.94748)(0.95^2)}{1.1^3} = \boxed{\mathbf{314.09}} \qquad \textbf{(C)}$$

[1/16/2012] On page 1117, in the solution to exercise 57.15, on the last displayed line, change 3.05582 to 3.055582. On the second to last line, change 3.05582 to 3.055582. On the last line, the final equation should be $400 + 2.46789 = \boxed{\mathbf{402.46789}}$.

[1/17/2012] On page 1121, in the second paragraph of 1., second line, add "a certain" before "multiple".

[1/17/2012] On page 1122, on the 13th line, change the line to:

FA be the specified death benefit. For a Type B policy, this is paid upon death in addition to the account value.

[1/17/2012] On page 1123, on the Year 3 line of the table, change the Account Value 6324.76 to 6324.75.

[1/17/2012] On page 1124, in the last line of the table, change the Cost of Insurance from 1205.06 to 1265.06.

[1/17/2012] On page 1124, in equation (58.9), change AV_t to AV_{t-1}.

[1/17/2012] On page 1125, in Table 58.1, in equation (58.9), change AV_t to AV_{t-1}.

[1/17/2012] On page 1126, 4 lines from the bottom, change 105,538.32 to 106,324.76.

[1/17/2012] On page 1127, in the second table, on the line for $t = 2$, change 572.37 to 572.36. On the last line, Pr_5 should be 651.30 instead of 641.30.

[1/17/2012] On page 1133, in the solution to exercise 58.1, replace the table with:

Year t	AV_{t-1}	Premium	Expense	CoI	Interest	AV_t
1	0.00	4000	1400	952.381	82.381	1730.00
2	1730.00	4000	400	1142.857	209.357	4396.50

On the last line, replace 4395.50 with 4396.50 and 1395.50 with 1396.50.

[1/17/2012] On page 1133, in the solution to exercise 58.2, on the second, third, and fourth lines (once apiece), replace 8957.56 with 8957.95.

[1/17/2012] On page 1133, in the solution to exercise 58.4, change 38,576 on the third and fourth displayed lines (once apiece) to 38,577, and change the final answer to 11,393.33.

[1/17/2012] On page 1133, in the solution to exercise 58.5, on the first displayed line, change 0.0005 to 0.001.

[1/17/2012] On page 1134, change the five displayed lines in the solution to exercise 58.6 to

$$\begin{aligned}\left(45{,}000+4500-\frac{2000}{1+i}\right)&=47{,}577\\ 49{,}500(1+i)-2000&=47{,}477\\ 1+i&=\frac{49{,}577}{49{,}500}\\ i&=\boxed{\mathbf{0.001556}}\end{aligned}$$

[1/17/2012] On page 1134, in the solution to exercise 58.7, on the fourth line, delete "so" and capitalize M in "mortality".

[1/17/2012] On page 1135, in the solution to exercise 58.11, the final answer should be 428.13.

[1/17/2012] On page 1135, in the solution to exercise 58.12, on the 7th line, change 9108.30 to 7578.90.

[1/17/2012] On page 1135, in the solution to Quiz 58-1, a pair of parentheses is missing in the numerator of the displayed line. The line should read

$$\mathrm{AV}_1=\frac{\big(40{,}000-5{,}000-0.02(100{,}000/1.04)\big)(1.06)}{1-0.02(1.06/1.04)}=\boxed{\mathbf{35{,}791.13}}$$

[1/17/2012] On page 1244, the final answer to question 17 should be $\boxed{\mathbf{69{,}456.07}}$.

[1/17/2012] On page 1298, the answer key for question 15 should be **(B)**. Correct the answer key on page 1293 as well.

[1/17/2012] On page 1304, the answer key for question 28 should be **(D)**. Correct the answer key on page 1293 as well.

[1/17/2012] On page 1315, the answer key for question 29 should be **(D)**. Correct the answer key on page 1305 as well.

[1/17/2012] On page 1333, the answer key for question 13 should be **(A)**. Correct the answer key on page 1328 as well.

[1/17/2012] On page 1336, the answer key for question 22 should be **(A)**. Correct the answer key on page 1328 as well.