Errata and Updates for ASM Exam MAS-I (First Edition Second Printing) Sorted by Page

Practice Exam 5 Question 6 is defective. See the correction to the question below. In Practice Exam 6 Question 11, the answer ranges are suitable for an annuity of 1 per year rather than 50,000 per year.

[5/28/2019] On page 135, in exercise 12.12, on the second line, change $k - l^{\text{th}}$ to $k - 1^{\text{th}}$.

[6/3/2019] On page 138, in exercise 12.13, 3 lines from the end of the solution, change $t/15$ to $x/15$.

[8/31/2018] On page 153, in the solution to exercise 13.30, on the first displayed line, change $10 + 7e^{-(10-x)/7}$ to $10 - 7e^{-(10-x)/7}$.

[10/28/2018] On page 159, in the solution to exercise 14.9, on the first line, change "with mean 1" to "on $[0, 1]$".

[10/28/2018] On page 206, two lines after formula (18.2), change $1-10(0.9^9) = 0.964844$ to $1-10(0.5^9) = 0.980469$.

[5/28/2019] On page 238, on the last line of the solution to Example 21G, change the left side of the equation to

$$200(\ddot{a}_{\overline{10}|} + {}_{10}E_{60}\,\ddot{a}_{70})$$

[5/28/2019] On pages 241–256, there are several questions with the phrase "The of", with a big space between the two words. In that space, add the words "actuarial present value". This error occurs in exercises 21.4, 21.7, 21.8, 21.18, 21.24, and in the solution to exercise 21.27 and twice in the solution to exercise 21.28.

[5/28/2019] On page 263, in exercise 22.2, on the second line, put parentheses around "mod 7".

[5/28/2019] On page 264, in exercise 22.3, on the third line, delete the pair of parentheses between mod and 8.

[10/28/2018] On page 292, in the box before exercises 24.8 and 24.9, on the third line, change "geometric" to "gamma".

[7/14/2019] On page 293, in exercise 24.12, on the last line, delete one of the "the"s.

[7/20/2018] On page 293, in the solution to exercise 24.1, change the answer key from **(C)** to **(B)**.

[7/1/2018] On page 293, in the solution to exercise 24.3, on the sixth line (the one with $u \longrightarrow$), change $\sqrt{(1-u)/2}$ to $1 - \sqrt{(1-u)/2}$. Replace the last two lines of the solution with

Comparing that fraction to the second number in each pair, we have $0.55 \le 1 - 0.3 = 0.7$, $0.37 \le 1 - 0.4 = 0.6$, $0.62 \ge 0.6$, and $0.77 \le 0.8$. We accept when the second number is less than or equal to the fraction, so we accept all except the third number. The average is $(0.3 + 0.4 + 0.8)/3 = \boxed{\mathbf{0.5}}$.

[10/28/2018] On page 295, change the first two lines of the solution to exercise 24.7 to

$$c = \max\left(\frac{f(x)}{g(x)}\right)$$
$$\frac{f(x)}{g(x)} = \frac{xe^{-x}}{1/(1+x)^2}$$

[7/14/2019] On page 296, replace the solution to exercise 24.12 with

Using the method in Ross, we generate two exponential random numbers with mean 1, $Y_1 = -\ln 0.25 = 1.386294$ and $Y_2 = -\ln 0.74 = 0.301105$. Then we accept if $Y_2 > (Y_1 - 1)^2/2$, or

$$0.301105 > (1.386294 - 1)^2/2 = 0.07461$$

which is true. The generated normal number is positive since $0.34 < 0.5$. The standard normal random number is 1.386294, and the normal random number is $2 + 5(1.386294) = \boxed{8.93147}$.

[10/28/2018] On page 314, in the solution to exercise 25.24, on the third line, change "by θ" to "be θ.

[11/6/2018] On page 330, on lines 6 through 9 from the bottom of the page, add a factor b before each k:

$$bk_5(16) = \frac{e^{-((16-5)^2)/2(8^2)}}{\sqrt{2\pi}} = 0.155012$$
$$bk_{12}(16) = \frac{e^{-((16-12)^2)/2(8^2)}}{\sqrt{2\pi}} = 0.352065$$
$$bk_{15}(16) = \frac{e^{-((16-15)^2)/2(8^2)}}{\sqrt{2\pi}} = 0.395838$$
$$bk_{20}(16) = \frac{e^{-((16-20)^2)/2(8^2)}}{\sqrt{2\pi}} = 0.352065$$

[3/2/2019] On pages 353–354, in Example 27C, $e(20)$ is the expected value of the random variable given that it is greater than 20. The parenthetical remark on page 354 starting with "Actually" is true, but not derived anywhere in the manual, so you may ignore it.

[9/4/2019] On page 379, Section 28.1, the smoothing method discussed is used if all observations are unique. If some observations are tied, an adjustment is made. Add the following after Quiz 28-1:

If there are ties among observations, then the highest quantile is assigned to the tied observation. For example, if the observations are {10, 22, 34, 34, 46}, then 34 is the 2/3 quantile but not the 1/2 quantile. Interpolation is then performed as above.

Example You are given the following losses:

10, 22, 34, 34, 46

Determine the smoothed empirical estimate of the 40th percentile and of the median.

Solution: For the 40th percentile, $0.4(5 + 1) = 2.4$, and we don't use the third observation since it is tied to the fourth. We interpolate between the second and fourth observations. We divided by 2, since $4 - 2 = 2$.

$$\hat{\pi}_{0.4} = \frac{(2.4-2)(34) + (4-2.4)(22)}{2} = \boxed{24.4}$$

For the median, $0.5(5 + 1) = 3$, and

$$\hat{\pi}_{0.5} = \frac{(3-2)(34) + (4-3)(22)}{2} = \boxed{28}$$

In this method, somewhat annoyingly, the median of a sample of odd size is not necessarily the middle element. □

[9/5/2019] On page 387, change exercise 28.18 to

From a sample of lives diagnosed with terminal cancer, you are given:

(i) The 25th percentile was 6.
(ii) The 75th percentile was 9.
(iii) The underlying distribution was Weibull.

Calculate $\hat{\tau}$ using percentile matching at the 25^{th} and 75^{th} percentiles.

[5/28/2019] On page 406, on the third line of the first paragraph of Subsection 29.1.3, change "observations" to "observation".

[7/29/2018] On page 418, in exercise 29.25, on the second line, the square symbol should be on the denominator:

$$S_X(x) = \frac{\theta^4}{(\theta^2 + x^2)^2}$$

[5/28/2019] On page 428, in the solution to exercise 29.30, on the fourth line, the right parenthesis in the denominator should be before the exponent $\alpha + 1$.

[5/28/2019] On page 431, in item 6 in Section 30.1 on the second line, delete "parameters".

[5/28/2019] On page 519, on the third line of the first paragraph, change "the next lesson" to "Lesson 37". On the last line of the page, change "the next lesson" to "Lesson 38".

[2/7/2019] On page 539, in equation (36.1), change $F(u)$ to $F(d)$.

[3/7/2019] On page 540, change Example 36B and its solution to

Example 36B A sample of 5 points is fitted to an exponential distribution with mean 6. Let $F_e(x)$ be the empirical distribution of the data and $F^*(x)$ the fitted exponential distribution.

Figure 36.2 is a graph of $F_e(x) - F^*(x)$.

Determine the Kolmogorov-Smirnov statistic for this fit.

Answer The largest absolute difference from 0 occurs right before $x = 9$. At that point, $F_e(9^-) = 3/5 = 0.6$ and $F^*(9^-) = 1 - e^{-9/6}$. The absolute difference is $|0.6 - (1 - e^{-9/6})| = \boxed{\mathbf{0.17687}}$.

[10/28/2018] On page 549, in exercise 36.22, in the third bullet, change all 4 denominators from n to $\sqrt{n}$.

[10/28/2018] On page 599, in the solution to exercise 40.3, on thee fifth line, change $\lambda^{-n\bar{X}}$ to $\lambda^{n\bar{X}}$.

[10/28/2018] On page 601, in the solution to exercise 40.9, on the second-to-last line, change the -2 at the beginning of the line and the -2 after "or" to 2; remove the minus signs.

[10/28/2018] On page 603, on the third line of the third paragraph, change "20^{th} percentile" to "15^{th} percentile".

[3/6/2019] On page 619, on the second line of the answer to Example 43D, change the second and third lines to

$$f(x) = \frac{\tau x^{\tau-1}}{\theta^\tau} e^{-(x/\theta)^\tau}$$

$$\ln f(x) = \ln \tau + (\tau - 1) \ln x - \tau \ln \theta - \left(\frac{x}{\theta}\right)^\tau$$

$\ln \tau$ may be added to either $c(\theta)$ or $d(x)$ on the next two lines.

[12/31/2018] On page 619, on the fourth line of the answer to Example 43D, change $b(\theta) = \theta^\tau$ to $b(\theta) = \theta^{-\tau}$.

[9/28/2019] On page 627, in the solution to exercise 43.8, on the last line, delete σ^2.

[7/6/2018] On page 635, in the fourth displayed line, on the right side in the exponent, change $\sum_{i=1}^p$ to $\sum_{i=2}^p$.

[8/12/2018] On page 642, change the first two lines of exercise 44.15 to

In a cumulative proportional odds model for an ordinal variable, the fitted model is

$$\ln \frac{\sum_{i=1}^j \hat{\pi}_i}{1 - \sum_{i=1}^j \hat{\pi}_i} = b_{0j} + b_1 x_1$$

[8/12/2018] On page 649, in the solution to exercise 44.23, two lines from the end, change $\Phi(1.01)$ to $\Phi(1.32)$.

[3/12/2019] On page 657, delete the first sentence of footnote 2. The delta method is not discussed in this course. The footnote may be helpful for remembering the components of the **W** matrix, but if you do not know the delta method, ignore the footnote.

[3/3/2020] On page 663, in exercise 45.5, on the eighth line, change "volumne" to "volume".

[10/1/2019] On page 673, in the solution to exercise 45.20, the final answer should be $\boxed{\begin{pmatrix}\mathbf{-1.2306}\\ \mathbf{0.4542}\end{pmatrix}}$.

[7/10/2018] On page 682, on the third line of Quiz 46-4, change "loglikehood" to "loglikelihood".

[6/28/2018] On page 704, in exercise 47.20, in the first bullet, change the two subscripts on the right to $i2$ and $i3$:

$\hat{y}_i = 20.0 - 1.5x_{i2} - 2.0x_{i3}$

[3/3/2020] On page 706, in the solution to exercise 47.7, on the last line, put a minus sign before 15: $-\dfrac{(-15)(2000)}{(1500)(18)}$.

[6/28/2018] On page 707, in the solution to exercise 47.12, on the third line, change b_2 to b_3.

[6/28/2018] On page 712, on the first line of Example 48B, change $\beta_5 x_6$ to $\beta_5 x_5$.

[3/3/2020] On page 714, on the fifth line of the page, add a "T" superscript to the third **X**: $(\mathbf{X}^\mathbf{T}\mathbf{X})^{-1}\mathbf{X}^\mathbf{T}\mathbf{y}$. Three lines above Section 48.2, replace the displayed line with

$$\sum(y_i - \bar{y})^2 - b_2^2\sum(x_i - \bar{x})^2 = 282.8133 - 1.1771^2(158.8333) = 61.71$$

Replace the last line before Section 49.2 with

$$F_{1,3} = \frac{(61.71 - 10.42)/1}{(10.42/3)} = \boxed{\mathbf{14.77}}$$

[6/28/2018] On page 715, in exercise 48.2, on the second line, replace x_{i7} with x_{i6}.

[7/17/2018] On page 719, in exercise 48.15, on the second line, replace $\beta_4 x_{i1} x_{i2}$ with $\beta_4 x_{i2} x_{i3}$.

[8/8/2018] On page 719, exercise 48.16 is a duplicate of exercise 48.13.

[8/8/2018] On page 720, in exercise 48.17, on the second line of the second bullet, put a period after 0.940. The statement beginning "A second regression equation" should be moved to a third bullet.

[6/28/2018] On page 721, in exercise 48.21, on the last line, change $\beta_3 = 0$ to $\beta_4 = 0$.

[8/8/2018] On page 727, in the solutions to exercises 48.10 and 48.11, on the displayed line in each solution, SSE_R and SSE_{UR} should be interchanged so that the numerator is $(\mathrm{SSE_R} - \mathrm{SSE_{UR}})/q$. In addition, in the solution to exercise 48.11, put parentheses around $n - p$ in the denominator.

[8/8/2018] On page 727, in the solution to exercise 48.13, on the first and second lines, delete the sentence fragment "The unrestricted model with 8 variables."

[8/8/2018] On page 727, in the solution to exercise 48.14, on the displayed line, change $n - k$ to $n - p$.

[4/22/2019] On page 728, in the solution to exercise 48.20, on the first line, change "$\beta_1 + \beta_2 = 1$" to "$\beta_2 + \beta_3 = 1$".

[8/8/2018] On page 737, in exercise 49.2, in the first bullet, change $\hat{y}$ to $\hat{y}_i$.

[8/8/2018] On page 737, in the solution to exercise 49.2, on the second line, change $\hat{y}$ to $\hat{y}_i$. Replace the last line with

$$r_3 = \frac{\hat{\varepsilon}_3}{s\sqrt{1-h_{33}}} = \frac{1.2}{2\sqrt{1-0.6}} = \boxed{\mathbf{0.948683}}$$

[6/28/2018] On page 743, two lines above equation (50.1), change $\beta_0 + \beta_1 x^*$ to $\beta_1 + \beta_2 x^*$.

[7/10/2018] On page 791, in the solution to exercise 52.5, on the first line, delete "a" before "Poisson".

[4/22/2019] On page 800, in exercise 53.5, change "mean square error" to "standard error" twice, once on the third line and once on the last line.

[7/2/2018] On page 804, one line below formula (54.1), change "variance of the residual ε" to "residual variance of the regression".

[7/2/2018] On page 805, in the first paragraph of Example 54A, change "The variance of the residual" to "The residual variance of the regression".

[7/2/2018] On page 807, in exercises 54.8 and 54.9, change "estimated variance of the residuals" to "estimated residual variance of the regression".

[7/2/2018] On page 808, in exercise 54.10, 2–3 lines from the end, delete the sentence beginning "For each model".

[7/2/2018] On page 808, in exercise 54.11, on the first line, change 28 to 29. In the table, delete the $\hat{\sigma}^2$ column.

[8/8/2018] On page 811, in the solution to exercise 54.2, on the second line, replace "6 models" with "7 models" and replace "5" with "6".

[8/8/2018] On pages 811–812, replace the solution to exercise 54.10 with

The mean squared error of the full model is $284/(60-5) = 5.163636$. Then

$$\begin{aligned}
C_p(0) &= \frac{326}{60} = 5.4333 \\
C_p(1) &= \frac{314 + 2(5.163636)}{60} = 5.4055 \\
C_p(2) &= \frac{303 + 2(2)(5.163636)}{60} = 5.3942 \\
C_p(3) &= \frac{293 + 2(3)(5.163636)}{60} = 5.4000 \\
C_p(4) &= \frac{284 + 2(4)(5.163636)}{60} = 5.4218
\end{aligned}$$

The **2-variable** model is selected.

[8/8/2018] On page 812, replace the solution to exercise 54.11 with

The estimated value of the mean square error of the model with 4 explanatory variables is

$$\hat{\sigma}^2 = \frac{\text{RSS}}{n-p} = \frac{132}{29-5} = 5.5$$

We calculate Mallow's C_p for each model.

$$\begin{aligned}
C_p(0) &= \frac{162}{29} = 5.586\\
C_p(1) &= \frac{145+2(1)(5.5)}{29} = 5.379\\
C_p(2) &= \frac{140+2(2)(5.5)}{29} = 5.586\\
C_p(3) &= \frac{136+2(3)(5.5)}{29} = 5.828\\
C_p(4) &= \frac{132+2(4)(5.5)}{29} = 6.069
\end{aligned}$$

The model with **1 explanatory variable** has the lowest C_p and is therefore the best.

[8/8/2018] On page 813, in the solution to exercise 54.14, on the fourth line, delete the first $\frac{15}{12}$, the one without parentheses.

[7/31/2018] On page 818, in the first displayed formula in Subsection 55.2.1, change $\bar{X}$ to $\bar{X}_j$. In the second displayed formula, change $\bar{x}_1$ to $\bar{x}_j$ and put a right parenthesis after $\bar{x}_j$.

[8/8/2018] On page 819, on the second line of Section 55.3, change "test data" to "training data".

[8/8/2018] On page 824, in the solution to exercise 55.11, on the second line, but a negative sign before $\frac{1}{2}\frac{\partial f}{\partial \beta_0}$.

[10/28/2018] On page 825, in the solution to exercise 55.14, item 2, change "latter takes the response into account" to "former takes the response into account".

[12/25/2018] On page 836, on the second line of the second paragraph, replace the first url with `www.maths.adelaide.edu.au/andrew.metcalfe/Data`.

[10/25/2018] On page 840, in the box for exercises 57.2 and 57.3, in the table for centered moving averages, change the entry for 2011Q3 from 127.65 to 127.625.

[7/24/2018] On page 852, in the solution to exercise 54.13, change the final answer to −1.25.

[3/21/2019] On page 860, replace the line before Example 60C with

If you are given the nonzero mean of a stationary AR(p) process, it must be subtracted from every x_{t-k} term.

In Example 60C on the first line, change "intercept" to "mean".

[4/4/2019] On page 865, in the solution to exercise 60.9, on the last line, change $z_{103|100}$ to $x_{103|100}$.

[9/4/2019] On page 866, replace the solution to exercise 60.10 with

Apply $y_t = 3 + 0.301y_{t-1} - 0.205y_{t-2} + 0.088y_{t-3}$ twice.

$$\begin{aligned}
\hat{x}_{2017|2016} &= 3 + 0.301(3.41) - 0.205(3.52) + 0.088(2.61) = 3.53449\\
\hat{x}_{2018|2016} &= 3 + 0.301(3.53449) - 0.205(3.41) + 0.088(3.52) = \boxed{\mathbf{3.67459}}
\end{aligned}$$

[4/22/2019] On page 871, in exercise 61.2, on the last line, change $\hat{z}_{22|20}$ to $\hat{x}_{22|20}$.

[7/26/2018] On page 873, in the solution to exercise 61.1, change the final answer to 5.83614.

[10/15/2019] On page 875, in the solution to exercise 61.8, change the last line to

$$23.04\left(1+\frac{1}{11}+\frac{6^2}{1105}\right)=\boxed{\mathbf{32.6749}}$$

[7/26/2018] On page 875, in the solution to exercise 61.14, on the first line, change 0.7 to 70 and $+0.3$ to -30.

[10/18/2018] On page 891, change formula (63.7) to

$$\text{Forecast error} = s_w\sqrt{\sum_{i=0}^{t-1} a^{2i}}$$

[10/18/2018] On page 892, in formula (63.7), change a^i to a^{2i}.

[10/28/2018] On page 905, in the solution to exercise 64.5, on the second to last line, delete the "is derived" that is before "by".

[3/12/2019] On page 939, in question 10, on the first line, delete the word "bridge".

[10/12/2018] On page 968, in question 6, in the two bullets, change "payment per loss" to "payment per payment". Change the last line of the question to

Calculate the percentage increase in the variance of payment per loss in 2016 over 2015.

[7/26/2018] On page 991, in question 27, on the second line, change β_2 to $\mathbf{x}_2$.

[7/26/2018] On page 991, in question 29, on the first bulleted line, insert a comma between 0.3111 and 0.5584.

[4/4/2019] On page 1007, in the solution to question 27, in the first denominator, change $(N-(p+1))$ to $n-p$ to be consistent with formula (48.3).

[10/28/2018] On page 1008, in the solution to question 34, on the first displayed line, change the denominator $2\pi x^2$ to $2\pi x^3$.

[10/28/2018] On page 1012, in the solution to question 11, on the last line, change $\dfrac{l_{52}}{l_{51}}$ to $\dfrac{l_{53}}{l_{52}}$.

[9/30/2018] On page 1029, replace the solution to question 41 with

The variance of the terms in the series, by formula (62.3), is

$$\sigma^2 = 4(1+0.8^2+0.6^2) = 8$$

The nonzero autocorrelations for the MA(2) series are at lags 1 and 2, based on formula (62.5).

$$\rho_1 = \frac{0.8+(0.8)(0.6)}{1+0.8^2+0.6^2} = 0.64$$
$$\rho_2 = \frac{0.6}{1+0.8^2+0.6^2} = 0.3$$

Using formula (61.1), the variance of the sample mean is

$$\begin{aligned}\operatorname{Var}(\bar{x}_t) &= \frac{\sigma^2}{n}\big(1+2(1-1/n)(\rho_1)+2(1-2/n)(\rho_2)\big)\\ &= \frac{8}{10}\big(1+2(0.9)(0.64)+2(0.8)(0.3)\big) = \boxed{\mathbf{2.1056}} \qquad \textbf{(E)}\end{aligned}$$

[7/26/2018] On page 1038, in the solution to question 30, on the displayed line, change 1.4 in the exponent to 0.4.

[10/28/2018] On page 1056, in the solution to question 11, on the last line, 13.883 should be multiplied by 50,000 to obtain a final answer of **694,150**.

[10/28/2018] On page 1063, in the solution to question 45, on the second and fourth lines (once apiece), change $\mathrm{Cov}(x_t, x_{t+1})$ to $\mathrm{Cov}(x_t, x_{t+2})$.

[8/13/2019] On page 1068, in the solution to question 37, on the first line, change the empty brakets "[]" to "[Section 21.1]".

[7/14/2019] On page 1070, in the solution to question 37, on the first line, change the empty brackets "[]" to "[Section 21.3]".

[7/16/2019] On page 1072, between the last two lines of the page, add

15. [**Section 21.1**] The joint probabilities of survival are:

$$\begin{aligned} p_{0:0} &= (1-0.03)^2 = 0.9409 \\ {}_2p_{0:0} &= 0.9409(1-0.09)^2 = 0.7792 \\ {}_3p_{0:0} &= 0.7792(1-0.14)^2 = 0.5763 \end{aligned}$$

so the probabilities of failure in each year are the differences:

$$\begin{aligned} q_{0:0} &= 1-0.9409 = 0.0591 \\ {}_{1|}q_{0:0} &= 0.9409-0.7792 = 0.1617 \\ {}_{2|}q_{0:0} &= 0.7792-0.5763 = 0.2029 \end{aligned}$$

and the answer is

$$100\left(\frac{0.0591}{1.05}+\frac{0.1617}{1.05^2}+\frac{0.2029}{1.05^3}\right) = \boxed{\mathbf{37.8}} \qquad \textbf{(C)}$$

[7/16/2019] On page 1073, between the line starting **21–23** and the line starting **25–28**, add

24. [**Section 4.1**] There is no discount in the first period and a 0.3 probability of being preferred in the second period. To calculate the probability of being preferred in the third period, we sum up the products:

$$(0.3)(0.6)+(0.6)(0.3)+(0.1)(0.1) = 0.37$$

We discount the probabilities.

$$40\left(\frac{0.3}{1.04}+\frac{0.37}{(1.04)(1.05)}\right) = \boxed{\mathbf{25.09}} \qquad \textbf{(B)}$$

Add the following before the last line on page 1073:

35. [**Lesson 16**] The compound mean is $100r\beta = 100(1.1)(1) = 110$. The compound variance is

$$\begin{aligned} \mathrm{Var}(S) &= \lambda\big(\mathbf{E}[X]^2+\mathrm{Var}(X)\big) \\ &= 100\big((r\beta)^2 + r\beta(1+\beta)\big) \\ &= 100\big(1.1^2 + 1.1(1)(2)\big) = 341 \end{aligned}$$

The 99th percentile of a normal distribution is 2.326. So we need $110 + 2.326\sqrt{341} = 152.95$, or **153** sets. Strictly speaking, a continuity correction should be made, so that the answer would be $152.95 + 0.5 = 153.45$, which would then have to be rounded up to 154, but the answer choice ranges did not require this refinement. **(E)**

After the end of page 1073, add

37. [**Lesson 16**] Combined teller services are 1 per 10 minutes plus 1 per 15 minutes, or $\frac{1}{10} + \frac{1}{15} = \frac{1}{6}$ per minute. With 360 minutes from 9 am to 3 pm, 60 services are completed. Of these, one third or 20 are deposits.

    The average deposit handled by tellers per deposit is the average of the deposit if it is less than 7500, 0 otherwise, or

$$\int_0^{7500} x f(x)\mathrm{d}x = \mathbf{E}[X \wedge 7500] - 7500\bigl(1 - F(7500)\bigr)$$

    Using the tables of distributions, this is

$$\frac{\theta}{\alpha - 1}\left(1 - \left(\frac{\theta}{\theta + 7500}\right)^{\alpha-1}\right) - 7500\left(\frac{\theta}{\theta + 7500}\right)^{\alpha} = 2500(1 - 0.4^2) - 7500(0.4^3) = 1620$$

    The expected total deposits is (20)(1620) = **32,400**. **(B)**

38. [**Lesson 16**] The charge per call X is \$3, plus \$1 if it lasts longer than 1 minute, \$1 if it lasts longer than 2 minutes, etc., or with T being the call time,

$$\begin{aligned}\mathbf{E}[X] &= 3 + \sum_{t=1}^{\infty} \Pr(T > t)\\ &= 3 + \sum_{t=1}^{\infty} e^{-t/4}\\ &= 3 + \frac{e^{-1/4}}{1 - e^{-1/4}}\\ &= 3 + \frac{0.778801}{1 - 0.778801} = 6.5208\end{aligned}$$

    Multiplying by the number of calls (100), the answer is **\$652.08**. **(D)**

39–40. *Questions 39–40 are not on the current Exam MAS-I syllabus*

[7/16/2019] On page 1076, between the lines starting **29=-31** and **33–37** add

32. [**Lesson 13**] In this Poisson process, a subprocess of losses greater than 100,000 is also a Poisson process with parameter $0.3\bigl(1 - F(100{,}000)\bigr) = 0.3(0.4) = 0.12$. The probability it is at least 1 is $1 - e^{-0.12} =$ **0.11308**. **(B)**

Between the lines starting **33–37** and **39–40** add

38. **[Section 4.1]** After one year, the state vector is the second row of the matrix, $\begin{pmatrix}0.3 & 0.5 & 0.2\end{pmatrix}$. After two years, the state vector is

$$\begin{pmatrix}0.3 & 0.5 & 0.2\end{pmatrix}\begin{pmatrix}0.60 & 0.30 & 0.10\\ 0.30 & 0.50 & 0.20\\ 0.00 & 0.40 & 0.60\end{pmatrix} = \begin{pmatrix}0.33 & 0.42 & 0.25\end{pmatrix}$$

The expected premium is 500 in the first year; 0.3(450) + 0.5(500) + 0.2(575) = 500 in the second year; and 0.33(450) + 0.42(500) + 0.25(575) = 502.25 in the third year. The expected present value is

$$500 + \frac{500}{1.05} + \frac{502.25}{1.05^2} = \boxed{1431.75} \qquad \textbf{(B)}$$

[7/16/2019] On page 1077, between the lines starting **3–4** and **6–9** add

5. **[Section 20.1]**

$$1000_{2|3}q_{60} = \frac{1000(l_{62} - l_{65})}{l_{60}} = \frac{1000(7{,}954{,}179 - 7{,}533{,}964)}{8{,}188{,}074} = \boxed{51.32} \qquad \textbf{(C)}$$

Between the lines starting **6–9** and **12–17** add

10. **[Lesson 29]** The likelihood function is

$$L(\theta) = \begin{cases} e^{-\sum Y_i + n\theta} & Y_i > \theta \text{ for all } Y_i \\ 0 & \text{otherwise} \end{cases}$$

The function grows with increasing θ. To maximize it, make θ as high as possible without being higher than any Y_i; in other words, make it the minimum of the Y_i. **(D)**

11. **[Lesson 29]** Let $A = \prod_{i-1}^{5} x_i = (0.92)(0.79)(0.90)(0.65)(0.86) = 0.365653$. Maximizing the likelihood function,

$$\begin{aligned} L(\theta) &= (\theta+1)^5 A^\theta \\ l(\theta) &= 5\ln(\theta+1) + \theta \ln A \\ \frac{\mathrm{d}l}{\mathrm{d}\theta} &= \frac{5}{\theta+1} + \ln A = 0 \\ \theta &= \frac{5}{-\ln A} - 1 = \frac{5}{1.00607} - 1 = \boxed{3.9698} \qquad \textbf{(E)} \end{aligned}$$

[8/13/2019] On page 1078, in the solution to question 31, on the first line, replace "[]" with "[**Section 47.2**]".

[7/16/2019] On page 1081, between the lines starting **12–35** and **38–39** add

36. **[Section 4.1]** Let x be the desired probability. The transition probability matrix is (making Preferred the first state)

$$\begin{pmatrix}0.8 & 0.2\\ x & 1-x\end{pmatrix}$$

We are given for a driver initially Standard

$$\begin{pmatrix}x & 1-x\end{pmatrix}\begin{pmatrix}0.2\\ 1-x\end{pmatrix} = 0.44$$

We solve for x.

$$\begin{aligned}0.2x + (1-x)^2 &= 0.44\\ 0.2x + 1 - 2x + x^2 - 0.44 &= 0\\ x^2 - 1.8x + 0.56 &= 0\\ (x-0.4)(x-1.4) &= 0\\ x &= \boxed{\mathbf{0.4}}, 1.4 \qquad \textbf{(B)}\end{aligned}$$

37. **[Section 21.1]** We must back out v.

$$\begin{aligned}{}_2p_{50} &= 1 - q_{50} - {}_{1|}q_{50} = 1 - 0.04 - 0.08 = 0.88\\ {}_2E_{50} &= 0.88v^2\\ v &= \sqrt{\frac{0.84}{0.88}} = 0.9770\end{aligned}$$

The term insurance's EPV is

$$A^{\,1}_{50:\overline{2|}} = 0.04(0.9770) + 0.08(0.9770^2) = \boxed{\mathbf{0.1154}} \qquad \textbf{(E)}$$

At the end of the page add

40. **[Lesson 4]** In the first year, payment only occurs for transition for State 1 to State 2, probability 0.4, expected payment (0.4)(70) = 28.

    In the second year, there's a 0.6 chance of being in State 1 at the beginning of the year, and then a (0.6)(0.4) = 0.24 chance of transition to State 2, expected payment (0.24)(70) = 16.8. There's a 0.4 chance of being in State 2 at the beginning of the second year, and then the expected payments occur upon transition to State 1 or State 3, expected value being (0.4)(0.1)(30) + (0.4)(0.2)(100) = 9.2. Total expected payment in step 2 is 16.8 + 9.2 = 26. EPV of both payments is $\frac{28}{1.1} + \frac{26}{1.1^2} = \boxed{\mathbf{46.94}}$. **(C)**

[7/16/2019] On page 1094, on the line above the line starting with **16–17**, add

15. **[Section 21.2]** This annuity is a 10-year certain annuity-immediate plus a 10-year deferred whole life annuity-immediate. The present value of the certain annuity is

$$a_{\overline{10|}} = \frac{1-(1/1.06^{10})}{0.06} = 7.3601$$

The deferred annuity-immediate's APV can be evaluated as

$${}_{10}E_{66}\, a_{76} = {}_{10}E_{66}(\ddot{a}_{76} - 1)$$

Using the illustrative Life Table, the sum of the two annuities is

$$7.3601 + (0.38753)(6.9493 - 1) = 9.6656$$

Therefore, the benefit is 250,000/9.6656 = $\boxed{\mathbf{25{,}865}}$. **(D)**

[10/22/2019] On page 1096, the solutions labeled as solutions to questions 8–10 are actually solutions to question 10–12. The solutions to questions 8 and 9 are:

8. **[Section 4.1]** The state vector at the end of week 2 is $\begin{pmatrix}0.2 & 0.8\end{pmatrix}$. Then the state vector at the end of week 3 is
$$\begin{pmatrix}0.2 & 0.8\end{pmatrix}\begin{pmatrix}0.9 & 0.1\\0.2 & 0.8\end{pmatrix} = \begin{pmatrix}0.34 & 0.66\end{pmatrix}$$
The probability of transition from state 1 to state 2 in the fourth week is $(0.34)(0.1) = \boxed{\mathbf{0.034}}$. **(B)**

9. **[Section 4.1]** The state vector at the end of one period is $\begin{pmatrix}0.8 & 0.2\end{pmatrix}$. At the end of two periods, it is
$$\begin{pmatrix}0.8 & 0.2\end{pmatrix}\begin{pmatrix}0.8 & 0.2\\1-p & p\end{pmatrix} = \begin{pmatrix}0.84-0.2p & 0.16+0.2p\end{pmatrix}$$
At the end of three periods, the second entry in the state vector is 0.312, which is equal to $0.2(0.84-0.2p)+p(0.16+0.2p)$, or
$$\begin{aligned}0.2(0.84-0.2p)+0.16p+0.2p^2 &= 0.312\\ 0.168+0.12p+0.2p^2 &= 0.312\\ 0.2p^2+0.12p-0.144 &= 0\\ p = \frac{-0.12+\sqrt{0.1296}}{0.4} &= \boxed{\mathbf{0.6}} \qquad \textbf{(E)}\end{aligned}$$

After the solution to question 17, add

18. **[Lesson 29]** For the first two observed losses x_i, the likelihood is the exponential probability density function $e^{-x_i/\theta}/\theta$. For the observed loss of 5000, the likelihood is the probability of a loss of at least 5000, or $s(5000) = e^{-5000/\theta}$. Multiplying the three likelihoods together:
$$\begin{aligned}L(\theta) &= \frac{1}{\theta^2}e^{-(1000+2500+5000)/\theta}\\ l(\theta) &= -2\ln\theta - \frac{8500}{\theta}\\ \frac{\mathrm{d}l}{\mathrm{d}\theta} &= -\frac{2}{\theta}+\frac{8500}{\theta^2} = 0\\ \theta &= \frac{8500}{2} = \boxed{\mathbf{4250}} \qquad \textbf{(E)}\end{aligned}$$

19. **[Lesson 29]** Since $F(x) = x^{k+1}$, the likelihood of one observation of 0.75 and one less than 0.75 is
$$\begin{aligned}L(k) &= F(0.75)f(0.75) = 0.75^{k+1}(k+1)0.75^k = (k+1)0.75^{2k+1}\\ l(k) &= \ln(k+1)+(2k+1)\ln 0.75\\ \frac{\mathrm{d}l}{\mathrm{d}k} &= \frac{1}{k+1}+2\ln 0.75 = 0\\ \hat{k} &= -\frac{1}{2\ln 0.75}-1 = \boxed{\mathbf{0.73803}} \qquad \textbf{(D)}\end{aligned}$$

The solutions numbered 18–21 should be renumbered 20–23.

[7/16/2019] On page 1098, after the line starting with **12-15**, add

16. [**Section 4.1**] We're interested in the next 3 time periods, starting immediately. The state vectors are $\begin{pmatrix}1 & 0\end{pmatrix}$ at the beginning of period 1, $\begin{pmatrix}0.7 & 0.3\end{pmatrix}$ at the beginning of period 2, and

$$\begin{pmatrix}0.7 & 0.3\end{pmatrix}\begin{pmatrix}0.7 & 0.3\\0.8 & 0.2\end{pmatrix} = \begin{pmatrix}0.73 & 0.27\end{pmatrix}$$

at the beginning of period 3. The cash flows paid are 0.3 times the probability of being in state 1, or

$$10\left(\frac{0.3}{1.05}+\frac{0.7(0.3)}{1.05^2}+\frac{0.73(0.3)}{1.05^3}\right) = 6.653709$$

The premiums are P times $0.3/1.05+0.27/1.05^2 = 0.530612$. Therefore, $P = 6.653709/0.530612 = \boxed{\mathbf{12.54}}$. **(D)**

The solutions numbered 16–23 should be renumbered 17–24.

[7/16/2019] On page 1104, after the solution to question 8, add

9. [**Lesson 11**] The parameter for the Poisson distribution is the integral of $\lambda(t)$ from 0 to ∞, or

$$\int_0^\infty \frac{100}{(1+t)^3}\,\mathrm{d}t = -\left.\frac{50}{(1+t)^2}\right|_0^\infty = \boxed{\mathbf{50}} \qquad \textbf{(B)}$$

10. [**Lesson 13**] The probability of a claim exceeding 1 million is $e^{-1{,}000{,}000/160{,}000} = 0.001930$. Thus the process of catastrophes is Poisson with parameter $200(0.001930) = 0.386091$, so interevent time is exponential with mean $1/0.386091 = 2.59$. The median of an exponential with mean θ is

$$\begin{aligned} e^{-x/\theta} &= 0.5\\ \frac{x}{\theta} &= -\ln 0.5 = \ln 2\\ x &= \theta\ln 2 \end{aligned}$$

and $2.59\ln 2 = \boxed{\mathbf{1.7953}}$. **(B)**

11. [**Lesson 16**] Mean payments for one year are $120(500) = 60000$. The variance is

$$\mathrm{Var}(S) = \lambda t\,\mathbf{E}[X^2] = 120(2\cdot 500^2) = 6\times 10^7$$

The probability we seek is

$$1-\Phi\left(\frac{70{,}000-60{,}000}{\sqrt{6\times 10^7}}\right) = 1-\Phi(1.291) = \boxed{\mathbf{0.0984}} \qquad \textbf{(D)}$$

[7/16/2019] On page 1106, at the beginning of the solution to question 12, replace "[]" with "[Section 21.2]".

[7/21/2019] On page 1110, at the beginning of the solution to question 14, replace "[]" with "[Section 21.3]"

[7/16/2019] On page 1110, replace the line beginning with **15.** with

15–16. *Questions 15–16 are not on the current Exam MAS-I syllabus*

Renumber the solutions to questions 16–21 to 17–22.

On page 1111, after the last line on the page, add

25. **[Lesson 46]** You can do the regression on a statistics calculator, but we'll carry out the steps.

$$\begin{aligned}
\bar{X} &= \frac{10+13+20+15+5}{5} = 12.6\\
\frac{\sum X_i^2}{5} &= \frac{10^2+13^2+20^2+15^2+5^2}{5} = 183.8\\
\hat{\sigma}_x^2 &= 183.8 - 12.6^2 = 25.04\\
\bar{Y} &= \frac{22+20+6+18+10}{5} = 15.2\\
\frac{\sum X_iY_i}{5} &= \frac{(10)(22)+(13)(20)+(20)(6)+(15)(18)+(5)(10)}{5} = 184\\
\widehat{\mathrm{Cov}}(X,Y) &= 184 - (12.6)(15.2) = -7.52\\
\hat{\beta} &= \frac{-7.52}{25.04} = -0.30032\\
\hat{\alpha} &= 15.2 - (-0.30032)(12.6) = 18.98403
\end{aligned}$$

At $X = 12$, the estimated value of Y is $18.98403 - 0.30032(12) = 15.38019$. So the residual is $18 - 15.38019 = \boxed{\mathbf{2.61981}}$. **(C)**

[7/21/2019] On page 1112, on the second line of the page, in the url, change "`f13-3`" to "`fall13-3`".

[7/16/2019] On page 1127, add the following after the line beginning **17–19**:

20. **[Section 48.3]** The fourth bullet is the error sum of squares. It follows that the standard error of the regression is

$$s^2 = \frac{\mathrm{SSE}}{n-2} = \frac{25}{4}$$

The third bullet provides the sum of the squared deviations of x_is from their means. By formula (48.6),

$$s_\beta^2 = \frac{s^2}{\sum(x_i-\bar{x})^2} = \frac{25/4}{50} = 0.125$$

The t coefficient for 4 degrees of freedom and 0.05 are in both tails is 2.776. The upper bound of the 95% confidence interval for β_1 is $4 + 2.776\sqrt{0.125} = \boxed{\mathbf{4.981}}$. **(A)**

Renumber the solution to question 20 to 21.

[8/12/2018] On page 1137, in the solution to question 33, on the second line, put "ln" before $\dfrac{\mu}{1-\mu}$.

[7/16/2019] On page 1150, delete the redundant line that is 6 lines from the bottom and begins with **28**.

[7/5/2018] On page 1163, in the solution to question 38, on the first line, change "gamma" to "Gaussian". On the fourth line, change "$a(x) = \theta, \underline{(}\theta) = -(x-1)^2/2x$" to "$a(x) = -(x-1)^2/2x, b(\theta) = \theta$".

[4/11/2019] On page 1169, in the solution to question 36, 3 lines from the end, the 5141.2 in the denominator should not be squared. The line should read

$$\sqrt{6.993}\sqrt{1+\frac{1}{30}+\frac{(50-66.6)^2}{5141.2}} = 2.7570$$

[9/13/2018] On page 1176, replace the solution to question 19 with

Since $n/(n+4) \to 1$ as $n \to \infty$, the limit of $\mathbf{E}[\hat{\alpha}_n]$ is 7, making statement I true.

The mean square error of $\hat{\alpha}_8$ is the square of the bias plus the variance:

$$\begin{aligned}
\text{bias}_{\hat{\alpha}_8}(\alpha) &= \frac{7(8)}{8+4} - 7 = 2\tfrac{1}{3}\\
\text{Var}(\hat{\alpha}_8) &= \frac{140(7)}{15} = 65\tfrac{1}{3}\\
\text{MSE}(\hat{\alpha}_8) &= (2\tfrac{1}{3})^2 + 65\tfrac{1}{3} = 70\tfrac{7}{9}
\end{aligned}$$

The variance approaches 70 from below as $n \to \infty$, since

$$\lim_{n\to\infty} \frac{n-1}{2n-1} = \frac{1}{2}$$

and

$$\frac{n-1}{2n-1} < \frac{n-1}{2n-2} = \frac{1}{2}$$

Since $70\frac{7}{9} > 70$, statement II is true.

Since the variance does not go to 0, we cannot be sure that $\hat{\alpha}_n$ is consistent, so statement III is false. **(B)**

[8/8/2018] On page 1182, in the solution to question 13, on the third line, change $N \geq 4$ to $N \geq 3$. On the fifth line, change "$N = 4$. **(D)**" to "$N = 3$. **(C)**". Delete the last sentence of the solution.

[8/8/2018] On page 1185, in the solution to question 32, on the third line, change "model 4" to "model 2".

[8/13/2019] On page 1190, change the reference for Spr 2007 Q31 from 45 to 47. Change the reference for Fall 2007 Q6 from NS to 27.

[7/21/2019] On pages 1191–1192, replace Tables C.3 and C.4 with the tables in the pages at the end of this errata listing. However, *subtract 1* from every lesson number higher than 41.

Table C.3: Lessons corresponding to questions on released CAS 3L exams Spring 2008 — Fall 2013

	CAS 3L Exams											
Q	Spr 2008	Fall 2008	Spr 2009	Fall 2009	Spr 2010	Fall 2010	Spr 2011	Fall 2011	Spr 2012	Fall 2012	Spr 2013	Fall 2013
1	1	11	NS	20	20	NS	NS	NS	NS	NS	NS	NS
2	25	11	NS	NS	NS	20	NS	NS	NS	NS	NS	NS
3	29	16	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4	37	29	NS	NS	NS	NS	NS	NS	20	NS	NS	NS
5	33	25	NS	NS	NS	NS	20	NS	NS	NS	NS	NS
6	35	29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
7	NS	40	4	NS	NS	NS	NS	NS	NS	NS	4	NS
8	NS	39	13	NS	NS	4	4	NS	4	4	4	4
9	46	37	13	21	NS	4	11	NS	11	13	11	11
10	11	NS	16	13	4	12	13	15	13	12	12	13
11	11	35	NS	13	4	11	16	12	16	16	16	16
12	16	NS	NS	NS	11	16	NS	NS	NS	21	NS	21
13	NS	20	NS	21	15	NS	NS	NS	NS	NS	21	NS
14	NS	NS	NS	NS	16	NS	NS	NS	NS	NS	21	NS
15	NS	NS	NS	NS	21	NS	NS	NS	NS	NS	NS	NS
16	NS	NS	4	4	NS	NS	4	4	NS	4	NS	4
17	NS	NS	27	27	NS	4	25	25	29	29	29	25
18	NS	NS	35	29	21	29	29	29	29	27	29	29
19	NS	4	29	29	4	29	27	29	29	25	25	29
20	4	21	33	38	25	27	37	33	35	29	33	NS
21	NS	NS	38	34	29	34	33	33	33	35	34	38
22	NS	NS	35	40	38	37	33	33	35	33	35	33
23	NS	NS	18	37	37	38	33	NS	40	37	NS	12
24	NS	NS	NS	NS	35	NS	33	NS	NS	NS	NS	NS
25	NS	4	46	38	NS	38	NS	46	46	NS	46	38

Table C.4: Lessons corresponding to questions on released CAS ST exams

Q	Spr 2014	Fall 2014	Spr 2015	Fal 2015	Spr 2016
1	13	15	13	11	14
2	15	13	12	11	12
3	16	16	16	16	16
4	29	29	25	25	29
5	25	31	31	29	25
6	29	25	29	31	32
7	29	32	29	29	29
8	NS	29	29	32	29
9	37	29	31	29	25
10	33	39	37	39	37
11	35	35	33	34	34
12	35	33	35	33	35
13	35	40	39	38	33
14	40	39	33	37	40
15	NS	33	35	39	39
16	NS	35	NS	35	NS
17	NS	NS	NS	NS	NS
18	NS	NS	NS	NS	NS
19	52	NS	NS	NS	NS
20	48	48	48	NS	48
21	52	52	49	48	49
22	NS	NS	48	52	49
23	NS	NS	NS	NS	NS
24	NS	NS	NS	NS	NS
25	NS	NS	NS	NS	NS

Table C.5: Lessons corresponding to questions on released CAS LC exams

Q	Spr 2014	Fall 2014	Spr 2015	Fall 2015	Spr 2016
1	NS	20	NS	NS	20
2	NS	NS	NS	20	20
3	NS	NS	NS	NS	NS
4	NS	NS	NS	NS	NS
5	NS	NS	NS	NS	NS
6	NS	NS	NS	NS	NS
7	NS	NS	NS	NS	NS
8	NS	NS	NS	NS	NS
9	NS	4	4	4	4
10	4	4	4	4	4
11	4	NS	NS	NS	NS
12	21	NS	NS	NS	21
13	NS	NS	NS	21	NS
14	NS	NS	NS	4	21
15	4	4	4	4	4