# Errata and Updates for the $12^{th}$ Edition of the ASM Manual for Exam FM/2 (Last updated 5/4/2018) sorted by page

[2/28/18] Page 255, Question 47. The last answer should be 7.98 without the % sign.

[7/30/17] Pages 294/295, Questions 8 and 15 are duplicates.

[2/28/18] Page 348, Question 35. $B_{24}$ should be equal to 1,345.50, so $1 + v^{16} = 1.715458937$ and $j = 2.1147446\%$. Therefore $I_{15} = 41.96$ ANS. (E)

[3/29/18] Page 434, Questions 3 and 4 are no longer on the syllabus.

[7/30/17] Page 468, Example 3. Answer choice (I) should be replaced by “A higher price of money”.

[4/17/2018] Page 549, Question 20. Replace “can be called by the issuer at par at any time after the 8th coupon is paid” by “can be called by the issuer at par on any coupon date immediately after the coupon has been paid, starting with the 8th coupon date.”

## Updates to the $12^{th}$ edition starting with the October 2018: Posted [5/4/2018]

Due to the elimination of the topic of “Sinking Funds” starting with the October 2018 exam, students should:

1. ignore Sections 6b, 6c and 6d pages 355 – 374 of the $12^{th}$ edition of the manual.
2. ignore the material under the caption “Sinking Funds” starting on the bottom of page 376 and running to the end of page 377.
3. ignore questions 8, 9 and 11 on page 380 and question 19 on page 381.
4. substitute the 10 questions below for those currently in the 6 practice exams at the end of the manual. Note that question 21 of Exam 4 was not on SF but was replaced by a new question to practice Convexity (Macaulay and modified).

## Replacement Questions

**Practice Exam 1 – Question 4:**
An investor took out a 30-year loan which he repays with annual payments of 1,500 at an annual effective interest rate of 4%. The payments are made at the end of the year. At the time of the $12^{th}$ payment, the investor pays an additional payment of 4,000 and wants to repay the remaining balance over 10 years. Calculate the revised annual payment.
(A) 1,682 (B) 1,729 (C) 1,783 (D) 1,825 (E) 1,848

**Practice Exam 1 – Question 10:**
A loan of 45,000 is being repaid with level annual payments of 3,200 for as long as necessary plus a final drop payment. All payments are made at the end of the year. The principal portion of the $9^{th}$ payment is 1.5 times the principal portion of the $2^{nd}$ payment. Calculate the drop payment.

(A) 1,495 (B) 1,521 (C) 1,546 (D) 1,584 (E) 1,597

**Practice Exam 2 – Question 16:**
A company has a liability of 50,000 to be paid 4 years from now. The company would like to be fully immunized against any change in yield rate. The only investments available are two-year and five-year zero-coupon bonds. The yield curve is flat at 3% annual effective interest rate. If X and Y are the face values of the two-year bond and five-year bond, respectively, compute the difference Y – X.
(A) 15,710 (B) 16,825 (C) 17,932 (D) 18,623 (E) 19,273

**Practice Exam 3 – Question 13:**
An insurance company has a liability of 100 at time 1 and another liability of 75 at time 6. The company invests in two assets to meet these liabilities. The first asset provides a cash flow of A at time 0 and the second asset provides a cash flow of B at time 4. At an annual effective interest rate of 6%, the first 2 conditions of the Redington immunization are satisfied. Compute the sum A + B and state whether the 3$^{rd}$ condition of the Redington immunization is satisfied.
(A) Sum = 175 and the 3$^{rd}$ condition of the Redington immunization is not satisfied.
(B) Sum = 174.22 and the 3$^{rd}$ condition of the Redington immunization is not satisfied.
(C) Sum = 174.22 and the 3$^{rd}$ condition of the Redington immunization is satisfied.
(D) Sum = 173.59 and the 3$^{rd}$ condition of the Redington immunization is not satisfied.
(E) Sum = 173.59 and the 3$^{rd}$ condition of the Redington immunization is satisfied.

**Practice Exam 3 – Question 22:**
Aiden has to pay 200 at the end of year 1, 400 at the end of year 2, and 500 at the end of year 3. The following bonds are currently available:

| Term | Annual Coupon Rate | Annual Yield Rate |
|---|---|---|
| 1 | 3% | 4.0% |
| 2 | 5% | 4.5% |
| 3 | 8% | 4.9% |

Aiden buys amounts of each bond to exactly match the three liabilities. Determine the total purchase price of the 1-year and 2-year bonds.
(A) 489 (B) 495 (C) 517 (D) 529 (E) 536

**Practice Exam 4 – Question 3:**
A 25-year loan is paid by level annual payments of 2,500 at the end of each year at an annual effective rate of interest $i$. The interest portion of the 10$^{th}$ payment is 1.4 times the interest portion of the 18$^{th}$ payment. Compute the principal repaid in the 14$^{th}$ payment.
(A) 564 (B) 592 (C) 632 (D) 671 (E) 709

**Practice Exam 4 – Question 11:**
Charlotte took a 2-year 15,000 loan that includes inflation protection. The annual effective rate of interest that she has to pay is 3% plus the rate of inflation. Given that the annual effective inflation rate during the second year is 1.2 times the inflation rate during the first year, the amount Charlotte will have to pay at the end of two years is 16,503. Compute the inflation rate during the second year.
(A) 1.45% (B) 1.72% (C) 1.92% (D) 2.06% (E) 2.17%

**Practice Exam 4 – Question 21:**

A 4-year annuity-immediate has level annual payments at an effective interest rate of 8%. Compute the excess of the modified convexity over the Macaulay convexity.
(A) 1.06 (B) 1.08 (C) 2.01 (D) 2.03 (E) 2.05

**Practice Exam 5 – Question 11:**
A company must pay liabilities with a present value of 563 and a modified duration of 3.95. The only investments available to immunize these liabilities are a 2-year zero-coupon bond and a 5-year zero-coupon bond. The company invests an amount of X in the 2-year bond and an amount of Y in the 5-year bond to satisfy the first 2 conditions of the Redington immunization at an annual effective interest rate of 4%. Compute the ratio Y/X.
(A) 1.38 (B) 1.73 (C) 2.36 (D) 2.91 (E) 3.07

**Practice Exam 6 – Question 9:**
A borrower of $25,000 agrees to pay back the loan with 16 level annual payments with the first payment due at the time the loan is issued. The annual effective rate of interest is 6% for the first 7 years and 5% for the remaining years. Starting with the 9$^{th}$ payment, the annual payments are increased by $500, and the number of annual payments is decreased accordingly. The final payment maybe larger than these new increased payments. Determine the last balloon payment.
(A) 3,238 (B) 3,358 (C) 3,479 (D) 3,669 (E) 3,819

## <u>Solution to the Replacement Questions</u>

**Practice Exam 1 – Question 4:**
The outstanding balance at time 12 prior to the additional payment is:
$B_{12} = 1{,}500a_{\overline{18|}.04} = 18{,}988.95$.
After the additional payment, the outstanding balance is 14,988.95.
To pay this remaining balance in 10 years, the revised annual payment is such that:
$Pa_{\overline{10|}.04} = 14{,}988.95$ that gives P = 1,848.00. ANS. (E)

**Practice Exam 1 – Question 10:**
The principal portions of the 9$^{th}$ and the 2$^{nd}$ payments are such that: $P_9 = P_2(1+i)^7$. This is a consequence of the formula $P_t = Rv^{n-t+1}$ .
Given the principal portion of the 9$^{th}$ payment is 1.5 times the principal portion of the 2$^{nd}$ payment, then: $(1+i)^7 = 1.5$ and $i = 1.5^{1/7} - 1 = .059634$.
Compute the number of full payments by solving for $n$ the equation: $45{,}000 = 3{,}200a_{\overline{n|}i}$.
Get $n = 31.49$.
Thus, there are 31 full payments of 3,200 and an additional drop payment of $P$ at time 32.
$45{,}000 = 3{,}200a_{\overline{31|}i} + Pv^{32} = 44{,}751.76 + Pv^{32}$.
Solving for $P$: $P = 248.24(1.059634)^{32} = 1584.37$. ANS. (D)

*Note:* The drop payment could be easily found using the calculator. Enter 5.9634 into I/Y, 45,000 +/- into PV, 3,200 into PMT, CPT N. Enter 31 into N, CPT FV, then multiply by 1.059634.
**Practice Exam 2 – Question 16:**
To fully immunize a liability cash outflow, three conditions must be met:
(a) The present value of the assets must be equal to the present value of the liability.

(b) The duration of the assets must be equal to the duration of the liability. (This could also be stated as: “The first derivative of the present value of the assets must be equal to the first derivative of the present value of the liabilities.”)
(c) There must be one asset cash inflow before and one after the liability cash outflow.
Let X be the face value of the 2-year zero coupon bond and Y be the face value of the 5-year zero coupon bond. Here are conditions (a) and (b):
(a) Setting the PV of the asset and liability cash flows equal: $Xv^2 + Yv^5 = 50{,}000v^4$
(b) Setting the duration of the assets and liability cash flows equal: $2Xv^2 + 5Yv^5 = 4(50{,}000)v^4$

Multiply the first equation by 5 and subtract the second equation from the first:
$3Xv^2 = 50{,}000v^4$ Or $X = \frac{50{,}000v^2}{3} = \frac{50{,}000(1.03)^{-2}}{3} = 15{,}709.93$
Substituting for X in the first equation, we have:
$$Y = \frac{50{,}000v^4 - 15{,}709.93v^2}{v^5} = 50{,}000(1.03) - 15{,}709.93(1.03)^3 = 34{,}333.34$$
The difference $Y - X = 34{,}333.34 - 15{,}709.93 = 18{,}623.41.$ ANS. (D)

**Practice Exam 3 – Question 13:**
The three conditions of the Redington immunization are:
(a) The present value of the assets must be equal to the present value of the liabilities.
(b) The duration of the assets must be equal to the duration of the liabilities. (This could also be stated as: “The first derivative of the present value of the assets must be equal to the first derivative of the present value of the liabilities.”)
(c) The convexity of the assets must be greater than the convexity of the liabilities. (This could also be stated as: “The second derivative of the present value of the assets must be greater than the second derivative of the present value of the liabilities.”)

Here are conditions (a) and (b):
(a) Setting PV(Assets) = PV(Liabilities) or $\sum A_t v^t = \sum L_t v^t$:
$A + Bv^4 = 100v + 75v^6 = 147.212$
(b) Setting Duration(Assets) = Duration(Liabilities) or $\sum tA_t v^t = \sum tL_t v^t$:
$0(A) + 4(Bv^4) = 1(100v) + 6(75v^6) = 411.572$

Solving the second equation: $B = \frac{411.572}{4v^4} = \frac{411.572(1.06)^4}{4} = 129.90$
Substituting for B in the first equation, we have: $A = 147.212 - 129.90(1.06)^{-4} = 44.32$
The sum $A + B = 44.32 + 129.90 = 174.22$

Condition (c): Convexity(Assets) > Convexity(Liabilities) or $\sum t^2 A_t v^t > \sum t^2 L_t v^t$
$\sum t^2 A_t v^t = 0(A) + 16(Bv^4) = 16(129.90)(1.06)^{-4} = 1646.29$
$\sum t^2 L_t v^t = 1(100v) + 36(75v^6) = 100(1.06)^{-1} + 36(75)(1.06)^{-6} = 1997.73$
The 3rd condition of the Redington immunization is not satisfied. ANS. (B)

**Practice Exam 3 – Question 22:**
Let X, Y, and Z be the face values of the 1-year, 2-year, and 3-year bonds, respectively.
Write 3 equations by matching assets and liability cash flows at times 1, 2, and 3 starting with time 3:
At time 3: $1.08Z = 500$, which gives $Z = \frac{500}{1.08} = 462.963$
At time 2: $1.05Y + .08Z = 400$, which gives $Y = \frac{400 - .08(462.963)}{1.05} = 345.679$

At time 1: $1.03X + .05Y + .08Z = 200$, which gives $X = \frac{200 - .05(345.679) - .08(462.963)}{1.03} = 141.436$
The total purchase price of the 1-year and 2-year bonds is calculated at an annual yield rate of 4% for the 1-year bond and 4.5% for the 2-year bond:
$Price = \frac{1.03X}{1.04} + \frac{.05Y}{1.045} + \frac{1.05Y}{1.045^2} = \frac{1.03(141.436)}{1.04} + \frac{.05(345.679)}{1.045} + \frac{1.05(345.679)}{1.045^2} = 488.99$ ANS. (A)

**Practice Exam 4 – Question 3:**
The interest portion of the 10th payment: $I_{10} = 2{,}500(1 - v^{25-10+1}) = 2{,}500(1 - v^{16})$
The interest portion of the 18th payment: $I_{18} = 2{,}500(1 - v^{25-18+1}) = 2{,}500(1 - v^{8})$
$I_{10} = 1.4I_{18}$ implies that $(1 - v^{16}) = 1.4(1 - v^8)$
Factor and simplify: $1 + v^8 = 1.4$ or $v = .4^{1/8}$ (or solve a quadratic equation in $v^8$)
The principal repaid in the 14th payment:
$P_{14} = 2{,}500v^{25-14+1} = 2{,}500v^{12} = 2{,}500(.4)^{12/8} = 2{,}500(.4)^{1.5} = 632.46$ ANS. (C)

**Practice Exam 4 – Question 11:**
Let $r$ be the inflation rate during the first year, then $1.2r$ is the inflation rate during the second year.
The annual effective rate of interest on the loan is $(.03 + r)$ during the first year and $.03 + 1.2r$ during the second year.
The payment amount at the end of two years: $16{,}503 = 15{,}000(1 + .03 + r)(1 + .03 + 1.2r)$
$1.1002 = (1.03 + r)(1.03 + 1.2r)$ or $1.2r^2 + 2.266r - 0.0393 = 0$

Using the quadratic formula: $r = \frac{-2.266 + \sqrt{2.266^2 - 4(1.2)(-0.0393)}}{2(1.2)} = .01719$
The inflation rate during the second year: $1.2r = (1.2)(.01719) = .02063 = 2.063\%$ ANS. (D)

**Practice Exam 4 – Question 21:**
Assume a level annual payment of 1, since the payment will cancel out.
The modified convexity $C_{mod} = \frac{\sum t(t+1)A_t v^{t+2}}{\sum A_t v^t} = \frac{1(2)v^3 + 2(3)v^4 + 3(4)v^5 + 4(5)v^6}{a_{\overline{4}|}} = \frac{26.76823}{3.31213} = 8.0819$
The Macaulay convexity $C_{Mac} = \frac{\sum t^2 A_t v^t}{\sum A_t v^t} = \frac{v + 4v^2 + 9v^3 + 16v^4}{a_{\overline{4}|}} = \frac{23.26025}{3.31213} = 7.0227$
$C_{mod} - C_{Mac} = 8.0819 - 7.0227 = 1.0592$ ANS. (A)

**Practice Exam 5 – Question 11:**
PV(Assets) = PV(Liabilities): $X + Y = 563$
Duration(Assets) = Duration (Liabilities): $\frac{2X+5Y}{563} = 3.95(1.04) = 4.108$ or $2X + 5Y = 2312.804$
(It is easier to compute the Macaulay duration of the assets. The Macaulay duration of the liabilities equals the modified duration times 1.04)
Multiply the first equation by 2 and subtract it from the 2nd equation:
$3Y = 2312.804 - 2(563) = 1186.804$ or $Y = 395.60$
Substituting for Y in the first equation, we have: $X = 563 - 395.60 = 167.40$
The ratio $\frac{Y}{X} = \frac{395.60}{167.40} = 2.3632$ ANS. (C)

**Practice Exam 6 – Question 9:**
Let P be the amount of the regular payments. Set the loan amount equal to the PV of all the payments.

$25{,}000 = P\ddot{a}_{\overline{7}|.06} + P\ddot{a}_{\overline{9}|.05}(1.06)^{-7}$ (it is also equal to $P\ddot{a}_{\overline{8}|.06} + Pa_{\overline{8}|.05}(1.06)^{-7}$)
$25{,}000 = P(5.917324 + 4.963463) = P(10.880787)$
Thus $P = 2{,}297.6279$.
The outstanding balance at time 7 after the 8th payment is made is equal to:
$B_7 = 2{,}297.6279a_{\overline{8}|.05} = 14{,}850.05796$
Under the new payment scheme, the 9th payment and after are increased by \$500 to $P' = 2{,}797.6279$
The number of the remaining payments is such that: $B_7 = 14{,}850.05796 = 2{,}797.6279a_{\overline{n}|.05}$.
Using a financial calculator, $n = 6.32$.
So there are 5 regular payments of 2,797.6279 and a 6th larger balloon payment of B such that:
$B_7 = 14{,}850.05796 = 2{,}797.6279a_{\overline{5}|.05} + B(1.05)^{-6}$
$B(1.05)^{-6} = 2{,}737.7932$, or $B = 3{,}668.90$ ANS. (D)