Errata for the 8th & 9th Printings of
"Understanding Digital Signal Processing, 2/E",
by Richard Lyons

I beg your pardon for the typographical errors in the book.
(I arranged to have roughly 80% of the following "typos"
corrected in earlier Printings of the book but, sadly, some sort
of strange mistake occurred at the publisher that reintroduced
these errors in the 8th & 9th Printings of the book! 😞)
It will not take long to make these corrections. I promise.
- Rick Lyons -

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Page 7: In the third line below Eq. (1-7), the text:

"... indicate that $X_{\text{sum}}(n)$ has a frequency ..."

The uppercase "X" should be lowercase "x" as:

"... indicate that $x_{\text{sum}}(n)$ has a frequency ..."

[Found by Angela Livingstone, 3/30/08; [Production Error]

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Page 31:

In the 3rd line above EQ. (2-6), in the text:

"... and negative bands, P and Q, just butt up ..."

the letters "P" & "Q" should be swapped making it:

"... and negative bands, Q and P, just butt up ..."

[Found by Jimmy Ceilidh [12/29/04].][Author Error]

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Page 34: In the 5th line down, the text:

"... where spectral replications do not butt up against each
other except at zero Hz."

is confusing. Please edit it as follows:

"... where spectral replications do not butt up against each
other except at zero Hz."

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Page 37: The "$f_s$" labels, within the arrows, at the very
bottom of Figure 2-13 should be "$f_s/2$".

[Found by Author [6/20/06].][Author Error]

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Page 38: In the fifth line up from the bottom of the page,
the text:

"... where $m_{\text{odd}}$ is an odd integer[14]."

should be changed to:

"... where $m_{\text{odd}}$ is an odd integer greater than one[14]."

[Found by Jim Murphy [9/14/05] & Justin Reeves [6/20/06].][Author Error]
Page 40: In the 2nd line below Eq. (2-14), the text:

"m = 2 provide an optimum ..."

should be changed to:

"m_{even} = 2 provide an optimum ..."

[Found by Justin Reeves, 6/20/06.][Author Error]

Page 42: In the middle of Table 2-2, on the right side, the text:

"m_{odd} is any positive odd integer ..."

should be changed to:

"m_{odd} is an odd integer greater than one ..."

[Found by Justin Reeves, 6/20/06.][Author Error]

Page 48: The incorrect letter "v" in the third line of Eq. (3-4d) should be replaced with a "·" multiplication symbol.

[Found by Uday Padmanabhan, 11/19/08.][Author Error]

Page 62: The second part of equation (3-18') printed as:

\[ x(n) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X'(m)e^{j2\pi nm/N} \]  

(3-18')

should have the lower limit of the summation changed to "m" instead of "n", as:

\[ x(n) = \frac{1}{\sqrt{N}} \sum_{m=0}^{N-1} X'(m)e^{j2\pi nm/N} \]  

(3-18')

[Found by Larry Ong, 2/19/08.][Author Error]

Page 62: On the sixth line of Section 3.5, the text:

"... answer is not "1."

should be replaced with

"... answer is not 1 kHz.

Page 77: For both Eq. (3-29) and Eq. (3-30), the "-1" characters should be deleted from the denominator of the cosine arguments. The cosine argument, in both equations, should be:

"...cos(2\pi n/N),"
Page 93: The last term in Equ. 3-37 has a missing minus sign in its exponent. The last term should be:

$$... + e^{-jq(K-1)}].$$

[Found by Stan Moore, 3/19/12][Production Error]

Page 122: The caption to Figure 3-47 was printed as:

"DTFT magnitude $|X_0(w)|$"

The "$w$" should be the Greek "$\omega$" character, making the caption:

"DTFT magnitude $|X_0(\omega)|$"

On page 134, in Figure 4-2, the lower right four twiddle factors:

$W_8^4, W_8^5, W_8^6, W_8^7$

should be

$-W_8^0, -W_8^1, -W_8^2, -W_8^3$

[Found by Saul Iverson, 10/3/17.][Author Error]

Page 135: On the 3rd line from the bottom, the "1" in:

"$e^{-j\pi} = 1$"

should be a minus 1 as

"$e^{-j\pi} = -1$"

[Found by Antoine Trux, 1/2/07.][Author Error]

Page 143: In Figure 4-10, in the middle stage there is the number 4 on the 1st and 2nd (counting down from the top) southeast-pointing arrows. Those 4s should not be there. The 4s should be on the 3rd and 4th southeast-pointing arrows of the middle stage as shown below.

![Diagram of Figure 4-10](image-url)
Page 241: Near the left side of Figure 6-21(a), the "Imag z" axis label is missing.

[Found by Nikhil Sarma, 4/28/04.] [Author Error]

Page 244: The normalized-frequency labeling (radians/sample) on the frequency axis of Figures 6-24(b) and 6-24(c) should be changed as:

-2\pi changed to -4\pi  
-\pi changed to -2\pi  
\pi changed to 2\pi  
2\pi changed to 4\pi

[Found by Author, 10/17/08.][Author Error]

Page 257: In the eleventh line below Eq. (6-87)

"... Figure 6-21(b). Knowing that ..."

should be changed to:

"... Figure 6-22(b). Knowing that ..."

[Found by Yancen Li (7/14/14)]; [Author Error]

Page 264: In the 6th line of the first full paragraph, the text:

"...squeezed in toward zero Hz."

should be:

"...squeezed in toward \(f_s/2\) Hz."

[Found by VV (vanamali), 3/12/09.] [Author Error]

Page 264: In the next to the last line of the first full paragraph there's a missing "|" vertical bar character indicating "magnitude". The text:

"...in \(|H_d(f_d) - \ldots\)"

should be:

"...in \(|H_d(f_d)| - \ldots\)"

[Found by Author, 7/14/05.][Author Error]

Page 265: In the first and third lines of the caption to Figure 6-32, the subscripted "c" in "f_c" should be an "a", as "f_a".

In the third line of the caption, the subscripted "c" in "H_c" should be an "a", as "H_a".

[Found by Author, 7/14/05.][Author Error]

Page 267: There is a missing "x(n)" factor in Equation (6-114), the first part of that equation should be:
\[ y(n) = 0.20482712 \cdot x(n) + 0.40965424 \cdot x(n-1) + \ldots \]

[Found by Kendall Castor-Perry, 5/3/09.] [Author Error]

Page 286: The feedback coefficient of the resonator in Figure 7-3, printed as:

\[ e^{i\omega r} \]

it should be changed to:

\[ e^{j\omega r} \]

[Found by Author, 7/14/09.] [Production Error]

Page 339: In Figure 8-3, the last fraction on the right of the second line down was printed as:

\[ \frac{(j)^6}{6!} \]

The letter "f" should be changed to the Greek letter \( \phi \), as:

\[ \frac{(j\phi)^6}{6!} \]

[Found by Prof. Kai-Kuang Ma, 2/28/05.] [Author Error]

Page 345: On the right side of Figure 8-8 the term \( e^{12\pi f_0 t} \) should be divided by two, making it

\[ e^{12\pi f_0 t}/2. \]

[Found by John Littig, 9/24/07.] [Author Error]

Page 353: In the sentence just before Eq. (8-17), the described notion of orthogonality of \( i(n) \) and \( q(n) \) is only conditionally true. Because this orthogonality topic was not described in sufficient detail, I suggest you strike out both the sentence just before Eq. (8-17) as well as Eq. (8-17) itself.

[Found by Ken Walsh, 5/9/06.] [Author Error]

Page 373: Item# 3 is not worded properly. In the second sentence printed as:

"We can widen (somewhat) and reduce the ..."

Please replace the above "(somewhat)" with:

"We can widen the passband and reduce the ..."

[Found by Author, 5/22/04.] [Author Error]

Page 389: In the seventh line of the second paragraph, the text is printed as:
"The lower the attenuation, the ...".

Please change the word "lower" to "greater" so that the text reads:

"The greater the attenuation, the ...".

[Found by Mark Kolber, 1/29/08.] [Author Error]

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Page 399: Equation (10-8) was printed as:

\[ Y(z) = \frac{1}{D} [X(n) + X(n)z^{-1} + X(n)z^{-2} + \ldots + X(n)z^{-D+1}] \tag{10-8} \]

The X(n) terms should all be X(z), so Eq. (10-8) should be

\[ Y(z) = \frac{1}{D} [X(z) + X(z)z^{-1} + X(z)z^{-2} + \ldots + X(z)z^{-D+1}] \tag{10-8} \]

[Found by Gurpal Gill, 4/7/05.] [Author Error]

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Page 430, fourth line down in 1st paragraph of Section 11.4:

The words printed as:

"... (N-1)-tap FIR filter ..."

Should be changed to read as:

"... N-tap FIR filter ..."

[Found by Author, 12/18/04.] [Author Error]

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Page 430: last line on the page: The words printed as:

"... through b(N) coefficient ..."

Should be changed to read as:

"... through b(N-1) coefficient ..."

[Found by Author, 12/18/04.] [Author Error]

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Page 478: in the fifth line down, delete the text:

"...followed by another K delay..."

In Figure 13-6(c) the final z^{-K} delay block should be deleted making that figure look as follows:

![Diagram](image)

[Found by Brian Frantz, 8/8/17.] [Author Error]

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Page 479: In Figure 13-6(b) the superscripted "-2" characters shown
by the large arrows below:

Should be changed from "-2" to "-1" making Figure 13-6(b) become:

Page 484: Equation (13-10) has suffered a series of "foul-ups" in different Printings of the book. Eq. (13-10) should be:

\[
W(m) = \sum_{n=0}^{N-1} e^{-j2\pi nm/N} - \frac{\beta}{2} \sum_{n=0}^{N-1} e^{j2\pi nm/N} \frac{1}{N} e^{-j2\pi nm/N} \]
\[
= \alpha \sum_{n=0}^{N-1} e^{-j2\pi nm/N} - \frac{\beta}{2} \sum_{n=0}^{N-1} e^{j2\pi n(m-1)/N} - \frac{\beta}{2} \sum_{n=0}^{N-1} e^{-j2\pi n(m+1)/N}. \quad (13-10)
\]

Page 488: Equation (13-18) has minus signs where equal signs should be. Equation (13-18) should be:

\[
x(0) = a(0) + jb(0)
\]
\[
x(1) = a(1) + jb(1)
\]
\[
x(2) = a(2) + jb(2)
\]
\[
\ldots
\]
\[
x(N-1) = a(N-1) + jb(N-1) \quad (13-18)
\]

Page 489: In the 3rd line below Eq. (13-22) change the text from:

"... in Eq. (13-40), ..."

to:

"... in Eq. (13-20), ..."
Page 496: In the 6th and 7th lines below Eq. (13-40) change the text from:

"... real, $X_a(N)$ through $X_a(2N-1)$ are merely the complex conjugates of their $X_a(0)$ through $X_a(N-1)$ counterparts ..."

to:

"... real, $X_a(N+1)$ through $X_a(2N-1)$ are merely the complex conjugates of their $X_a(N-1)$ through $X_a(1)$ counterparts ..."

[Found by Antoine Trux, 1/11/07.][Author Error]

I (the author) suggest you write the following in the book's margin:

"$X_{a, real}(N) = X_r(0) - X_i(0)$

"$X_{a, imag}(N) = 0$"

Page 518: For more accurate results, the "12/M" factor at the beginning of Eq. (13-70) should be changed to $\sqrt{12/M}$. Thus Eq. (13-70) should be:

$$y_{desired}(n) = \sqrt{\frac{12}{M}} \cdot \sigma' \cdot \left[ \sum_{k=1}^{M} X_k(n) \right] - \frac{M}{2} + \mu'.$$  

(13-70)

[Found by Bharat Pathak, 7/13/07.][Author Error]

Page 519: Under Section 13.13, Sharpened FIR Filters, the second sentence in the opening paragraph is printed as:

"Actually, we can a filter's double stopband ..."

Please move the word "double" in front of the "a", resulting in:

"Actually, we can double a filter's stopband ..."

[Found by Chris Frailey, 12/8/04.][Author Error]

Page 548: 4th line below Eq. (13-107), change the text:

"... 0.26° using ..."

to

"... 0.28° using ...".

For preciseness, you might note on Figure 13-59 that the error is $-0.28°$ at True $\theta = -45°$, and the error is $+0.28°$ at True $\theta = +45°$, as shown in the following figure.
[Found by Chris Zarowski, 4/27/06.][Author Error]

**Page 549:** 4th line below Eq. (13-109'), change the text:

"... error is 0.26° for ..."

to

"...error is 0.28° for ...".

[Found by Chris Zarowski, 4/27/06.][Author Error]

**Page 560:** In Figure 13-70(b), on the right side in the "Section 3, r = 1" part of the figure, there should be three stages of delay lines instead of only two stages as shown in the figure. That "Section 3, r = 1" part of the figure should look like the following:

![Diagram of three stages of delay lines](image)

[Found by Mike Totham, 8/31/07.][Author Error]

**Page 561:** Equation (13-123) has a missing 1/N scale factor in front of the summation. That equation should be:

$$ M(q) = \frac{1}{N} \sum_{k=qN}^{(q+1)N-1} x(n) $$

(13-123)

[Found by Author, 8/24/08.][Production Error]

**Page 569:** In the right $X_{int}(m)$ column of Table 13-8, the underline character associated with row $m = 9$ should be a zero "0" value as follows:

<table>
<thead>
<tr>
<th>$m$</th>
<th>$X_{int}(m)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

[Found by Author, 3/21/09.][Production Error]

**Page 574:** In Figure 13-77(a), the "log(R)" factor applied to the adder should be two times the log of R as:
2\log(R).

[Found by Mark Borgerding, 6/8/05.][Author Error]

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**Page 575:** (At the time of the fifth printing:)

The two labels in Figure 13-78(c) were strangely messed up during the typesetting process. The
\[ \alpha = 0.7 \quad \text{and the} \quad \alpha = 0.09 \]
labeled above the graphs should be changed to
\[ \alpha = 0.2 \quad \text{and the} \quad \alpha = 0.05 \]
The bottom line in the figure caption is printed as:
"... (c) \( E(n) \) for \( \alpha = 0.7 \) and \( \alpha = 0.9 \)."
That caption text should be changed to:
"... (c) \( E(n) \) for \( \alpha = 0.2 \) and \( \alpha = 0.05 \)."
[Found by Author, 3/24/05.][Production Error]

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**Page 607:** Two corrections: In the second line of Eq. (D-7), the term:
"... -\cos(\omega t) \] ...  
should be:
"... -\cos(2\omega t) \] ...  
In the third line of Eq. (D-7), the term:
"... -\frac{1}{2}(\sin(\omega t))..."  
should be:
"... -\frac{1}{4}(\sin(2\omega t))..."
[Found by Julian Vrbancich, 10/23/12; [Author Error]

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**Page 610:** The final ratio at the end of Eq. (D-12) **MAY** be printed as:
\[ \frac{(b-a)^2}{12} \] .
Make sure the numerator looks like (with a PLUS sign):
\[ \frac{(b+a)^2}{12} \] .
[Found by Author, 1/15/05.[Author Error]
Page 614: In the sentence just following Eq. (E-2), there is a missing "P_1/P_2" ratio. That sentence should read as:

"The logarithmic function 10 \cdot \log_{10}(P_1/P_2), plotted in ..."

[Found by Nikhil Sarma, 5/18/05.] [Author Error]

Page 623: Under the "Chebyshev Function": the fifth line down is printed as:

"...ripples in the passband and flat passbands..."

It should be printed as:

"...ripples in the passband and a flat stopband..."

[Found by Mike Beliard, 1/29/05.] [Author Error]

Below are corrections to an unexplainable (!!) number of errors in the Index. (No one that I spoke to at the publisher's seems to know how this happened.) Although some people do not think these corrections are important, I do because the Index is a VERY important part of a book. On behalf of my publisher, I beg your pardon for the following errors.

[-Rick-]

Page 657, Right Column:

The top-level Index entry "Averaging" is missing.
The following lines:

Automatic gain control (AGC), 548, 571
   block, 561
   coherent, 412
   ... should be:

Automatic gain control (AGC), 548, 571

Averaging
   block, 561
   coherent, 412
   ...

Page 657, Right Column:

In the following lines:

Averaging
   ... 
   ... moving, 398

the page numbers 152, 430, & 578 should be added making the line:

Averaging
   ...
   ...
moving, 152, 398, 430, 578

Page 659, Left Column:

Under the Index entry:

Discrete-time Fourier transform (DFT)
  define, 88
  an example, 121

the correct acronym spelling and page number should be

Discrete-time Fourier transform (DTFT)
  define, 87
  an example, 121

Page 660, Left Column:

In the following lines:

Filtering/filters (cont.)

... moving average, 152, 398

the page numbers 430 & 578 should be added making the line:

Filtering/filters (cont.)

... moving average, 152, 398, 430, 578

Page 660, Left Column:

There is a missing Index entry. The lines originally printed as:

Filtering/filters (cont.)

... prototype, 243
  recursive, 242

should have the additional Index entry of

Filtering/filters (cont.)

... prototype, 243
  quadrature filter, 629
  recursive, 242

Page 660, Left Column:

There is a missing page number. The line originally printed as:

Filtering/filters (cont.)

... transposed structure, 241
should have the additional 558 page number included

Filtering/filters (cont.)
...
  transposed structure, 241, 558

Page 662, Left Column:
Under the Index entry:
  L'Hospital's rule, 95
the correct spelling (no "s") and a missing page number are
  L'Hopital's rule, 95, 369

Page 663, Left Column:
There is a missing page number. The line originally printed as:
  Passband ripple, 186, 629
should have the additional page number of
  Passband ripple, 186, 275, 629

Page 663, Left Column:
In the following line:
  Quadratic factorization formula, 224
add the following 240 page number making the line:
  Quadratic factorization formula, 224, 240

Page 663, Right Column:
There is an inappropriate Index entry. In the lines originally printed as:
  Quadrature signals, 335
  recursive filters, 242
  Quantization, coefficient/errors, 272-273
the center Index entry ("recursive filters") should be deleted as
  Quadrature signals, 335
  Quantization, coefficient/errors, 272-273

Page 665, Left Column:
There is a missing page number and incorrect page numbers.
The lines originally printed as:
  Transposed filters, 558
  Transversal filter, 505, 156-631
should be corrected to:

Transposed filters, 241, 558
Transversal filter, 155

Page 665, Right Column:

Under the Index entry:

Windows
  Kaiser, 81, 178-183

page numbers should be

Windows
  Kaiser, 179-183

Dear Reader, if you find any additional errors, no matter how trivial, please notify me at: R.Lyons@ieee.org
I'd sure appreciate hearing from you and I promise I'll reply to your E-mail.

Thanks,
[-Rick Lyons-]