Holton DSP Errata

7/15 up "…and $n = 364$ is December 31…"

14/1 "… Chapters 6 and 13 …"

31/4

$$\begin{aligned}\mathrm{Im}(x[n]) &= \tfrac{1}{2j}(x[n] - x^*[n]) = \frac{1}{2j}\left(\begin{array}{l}(2+j)\delta[n+1] + \delta[n] - 3j\delta[n-1] \\ -(2-j)\delta[n+1] + \delta[n] + 3j\delta[n-1]\end{array}\right) \\ &= (2j\delta[n+1] - 6j\delta[n-1])/2j = \delta[n+1] - 3\delta[n-1]\end{aligned}$$

47/19 In Section 1.9.3 "The output of the system is $y[n] = T\{x[n]\} = x^2[n]$."

85/2 Equation should be

$$\sum_{k=-\infty}^{\infty} |h[k]| < \infty$$

91/2 up

$$\begin{aligned}\mathbf{x}^T &= [x[n-1] \;\; x[n-2] \;\; \cdots \;\; x[n-N]] \\ \mathbf{y}^T &= [y[n-1] \;\; y[n-2] \;\; \cdots \;\; y[n-N]]\end{aligned}$$

115/8 Example 3.1(b): "Find the output of this system, $y[n]$, when the input is $x[n] = e^{j\pi n/3}$."

115/13 Example 3.1(b) Solution: "When $x[n] = e^{j\pi n/3}$ …"

115/6 up Example 3.2(b): "Find the output of this system, $y[n]$, when the input is $x[n] = e^{j\pi n/3}$."

115/5 up Example 3.2(c): "Find the output of this system, $y[n]$, when the input is $x[n] = e^{j\pi n/2}$."

120 The equation/figure in the middle of the page (after "…of different frequencies") is wrong! Here is the replacement:

integral of **scaled** **exponential sequences**

$$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\omega) e^{j\omega n} d\omega$$

141 Equation 3.29 should be numbered 3.30.

151 Two display equations have errant periods in them:

$$
\begin{aligned}
y_{FIR}[n] &= \cos(0.15\pi n - 3\pi) + \cos(0.30\pi n - 6\pi) + \cos(0.45\pi n - 9\pi) \\
&= \cos(0.15\pi(n-20)) + \cos(0.30\pi(n-20)) + \cos(0.45\pi(n-20)) \\
&= x[n-20]
\end{aligned}
$$

$$
\begin{aligned}
y_{IIR}[n] &= \cos(0.15\pi n - 1.33\pi) + \cos(0.30\pi n - 2.88\pi) + \cos(0.45\pi n - 5.23\pi) \\
&= \cos(0.15\pi(n-8.87)) + \cos(0.30\pi(n-9.60)) + \cos(0.45\pi(n-11.62))
\end{aligned}
$$

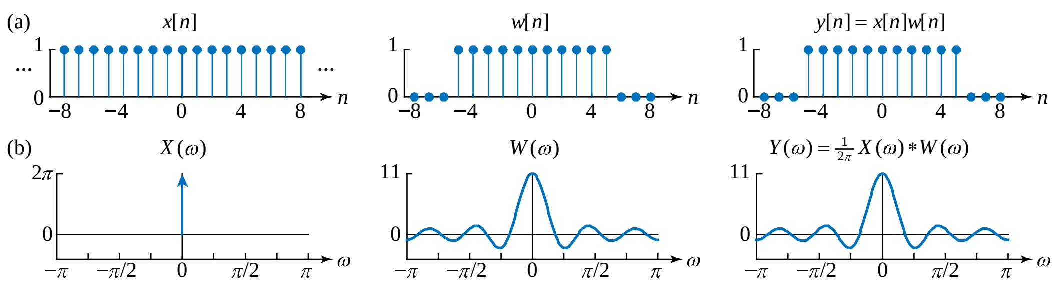
154 Second display equation in Example 3.19: the last term in the first line should be $e^{-j4\omega}$

$$
\begin{array}{ccccccccc}
X(\omega) & = & e^{j4\omega} & + & 2e^{j2\omega} & + & 2e^{-j2\omega} & + & e^{-j4\omega} \\
\updownarrow & & \updownarrow & & \updownarrow & & \updownarrow & & \updownarrow \\
x[n] & = & \delta[n+4] & + & 2\delta[n+2] & + & 2\delta[n-2] & + & \delta[n-4]
\end{array}
$$

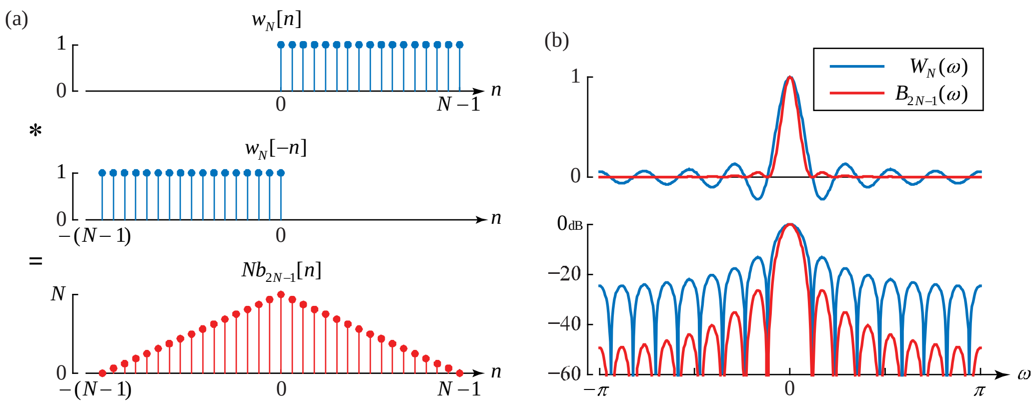
157/15 Code should be ‘`x = X`’ rather than ‘`out = X`’

161/2 up $\cos 3\pi/4 = \cos(3\pi/4 - 2\pi) = \cos(-5\pi/4)$

179 Figure 13.38. The plots for $w[n]$ and $y[n] = x[n]w[n]$ should each only have 11 points, $-5 \le n \le 5$.



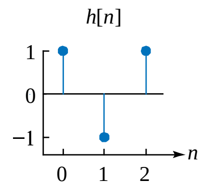
185 Figure 3.44. The red trace in part a) is $Nb_{2N-1}[n]$, not $b_{2N-1}[n]$.



189/3 Purely cosmetic, but last terms don’t need parentheses:

$$
H(\omega) = \frac{2}{1 - \frac{3}{4}e^{-j\omega} + \frac{1}{8}e^{-j2\omega}} = \frac{2}{(1 - \frac{1}{2}e^{-j\omega})(1 - \frac{1}{4}e^{-j\omega})} = \frac{4}{1 - \frac{1}{2}e^{-j\omega}} - \frac{2}{1 - \frac{1}{4}e^{-j\omega}}
$$

192 Figure 3.48 is incorrect. Here is the replacement:



209/4 Equation should be

$$H(\omega)=\frac{B(\omega)}{A(\omega)}=\frac{\sum_{m=0}^{M} b_m e^{-j\omega m}}{\sum_{n=0}^{N} a_n e^{-j\omega n}}$$

229/3 up Since $\alpha = 0.75$, the display equation and the following line of text should be

$$H(z)=\frac{z\,\cancel{(z-\frac{3}{4})}}{(z-\frac{3}{4})^{\cancel{2}}}=\frac{z}{z-\frac{3}{4}}$$

A zero at $z = 3/4$ has cancelled one of the poles at $z = 3/4$, leaving a single real pole and a single zero.

230/1 up The display equation should be

$$H(z)=\frac{z\,\cancel{(z+\frac{3}{4})}}{(z+\frac{3}{4})^{\cancel{2}}}=\frac{z}{z+\frac{3}{4}}$$

232/6 Equation 4.10

$$H(z)=z^{-n_0}(b_0+b_1z^{-1}+\cdots+b_{N-1}z^{-(N-1)})=z^{-(n_0+N-1)}(b_0z^{N-1}+b_1z^{N-2}+\cdots+b_{N-1})$$
$$=\frac{b_0z^{N-1}+b_1z^{N-2}+\cdots+b_{N-1}}{z^{n_0+N-1}}$$

250 Cosmetic: denominator terms in second and third $H(z)$ don't need parentheses

258 The display equation after Equation (4.25) should have $H(z)$, not $H(z^{-1})$:

$$H(z)=C\frac{\prod_{k=0}^{M-1}(z-z_k)}{\prod_{k=0}^{N-1}(z-p_k)}$$

261/12 up Cosmetic

$$H(z)=1-\frac{1}{4}\frac{z^{-1}}{1-\frac{1}{4}z^{-1}}=\frac{1-\frac{1}{2}z^{-1}}{1-\frac{1}{4}z^{-1}},\qquad |z|>\tfrac{1}{4}$$

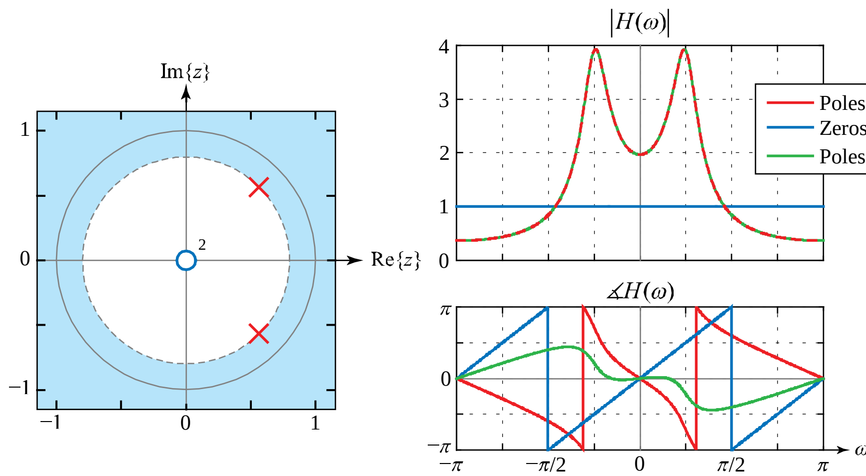
272 Figure 4.30a) The equation above the figure should read $h_I[n]=-5\delta[n]-15(-1.5)^n u[-n-1]$

278 Problem 4-12. It should be "…and that $F(0)=8$"

305 Figure 5.23 The legend for the red trace should say, "Pole at $z=0.9$"

305 Example 5.17 "Assume we have a cosine signal with a DC level added, $x[n]=1+\cos n\pi/4$ …"

307/1 Figure 5.24 should have two zeros. The first line of text under the figure should read, "The zeros at z = 0 have…".



366/1 I Equation (6.12) Cosmetic:

$$X_e(\omega)=\mathfrak{F}\{x_e[n]\}=\mathfrak{F}\{x[n]s[n]\}=\frac{1}{2\pi}X(\omega)*S(\omega)=\frac{1}{2\pi}\left\{X(\omega)*\frac{2\pi}{D}\sum_{k=0}^{D-1}\delta(\omega-2\pi k/D)\right\}$$
$$=\frac{1}{\cancel{2\pi}}\frac{\cancel{2\pi}}{D}\sum_{k=0}^{D-1}X(\omega)*\delta(\omega-2\pi k/D)=\frac{1}{D}\sum_{k=0}^{D-1}X(\omega-2\pi k/D)$$

410/3 up The display equation at the bottom of the page is wrong

$$H(\omega)=\sum_{n=0}^{N-1}h[n]e^{-j\omega n}=e^{-j\omega(N-1)/2}\sum_{n=0}^{N-1}h[n]e^{-j\omega(n-(N-1)/2)}=e^{-j\omega M}\sum_{n=0}^{2M}h[n]e^{-j\omega(n-M)}$$

411/4 up The upper limit of the summation in the first line of the display equation should be $2M$. The rest is the same.

$$
\begin{aligned}
H(\omega) &= e^{-j\omega M}\sum_{n=0}^{2M} h[n]e^{-j\omega(n-M)} \\
&= e^{-j\omega M}\left(\begin{array}{l} h[0]e^{j\omega M} + h[1]e^{j\omega M-1} + \cdots + h[M-1]e^{j\omega} + h[M] + h[M+1]e^{-j\omega} + \cdots \\ + h[2M-1]e^{-j\omega M+1} + h[2M]e^{-j\omega M} \end{array}\right) \\
&= e^{-j\omega M}\left(\begin{array}{l} h[0]e^{j\omega M} + h[1]e^{j\omega M-1} + \cdots + h[M-1]e^{j\omega} + h[M] + h[M-1]e^{-j\omega} + \cdots \\ + h[1]e^{-j\omega M+1} + h[0]e^{-j\omega M} \end{array}\right) \\
&= e^{-j\omega M}\left(\begin{array}{l} h[0]\left(e^{j\omega M} + e^{-j\omega M}\right) + h[1]\left(e^{j\omega M-1} + e^{j\omega M-1}\right) + \cdots \\ + h[M-1]\left(e^{j\omega} + e^{j\omega}\right) + h[M] \end{array}\right) \\
&= e^{-j\omega M}\left(\underbrace{h[M]}_{a[0]} + \underbrace{2h[M-1]}_{a[1]}\cos\omega + \cdots + \underbrace{2h[1]}_{a[M-1]}\cos\omega(M-1) + \underbrace{2h[0]}_{a[M]}\cos\omega M\right) \\
&= e^{-j\omega M}\underbrace{\sum_{m=0}^{M} a[m]\cos m\omega}_{A(\omega)} \\
&= e^{-j\omega M}A(\omega)
\end{aligned}
$$

414 Table 7.2

Type	Must $A(0)=0$?	Must $A(\pi)=0$?	Lowpass?	Highpass?	Bandpass?	Bandstop?
I	✗	✗	✓	✓	✓	✓
II	✗	✓	✓	✗	✓	✗
III	✓	✓	✗	✗	✓	✗
IV	✓	✗	✗	✓	✓	✗

421 Equation 7.9

$$
\begin{aligned}
W(\omega) &= \mathfrak{F}\{\mathrm{rect}_N(n)\} = \sum_{n=-(N-1)/2}^{(N-1)/2} e^{-j\omega n} = \sum_{n=0}^{N-1} e^{-j\omega(n-(N-1)/2)} = e^{j\omega(N-1)/2}\sum_{n=0}^{N-1} e^{-j\omega n} \\
&= e^{j\omega(N-1)/2}\frac{1-e^{-j\omega N}}{1-e^{-j\omega}} = e^{j\omega(N-1)/2}\frac{e^{-j\omega N/2}}{e^{-j\omega/2}}\left(\frac{e^{j\omega N/2}-e^{-j\omega N/2}}{e^{j\omega/2}-e^{-j\omega/2}}\right) \\
&= \frac{\sin\omega N/2}{\sin\omega/2} = N\frac{\mathrm{sinc}\,\omega N/2}{\mathrm{sinc}\,\omega/2}
\end{aligned}
$$

442/17-23 Cosmetic: all instance of $h_{lp}[n]$ should be $h_{LP}[n]$, $h_{hp}[n]$ should be $h_{HP}[n]$, $H_{lp}(\omega)$ should be $H_{LP}(\omega)$ and $H_{hp}(\omega)$ should be $H_{HP}(\omega)$,

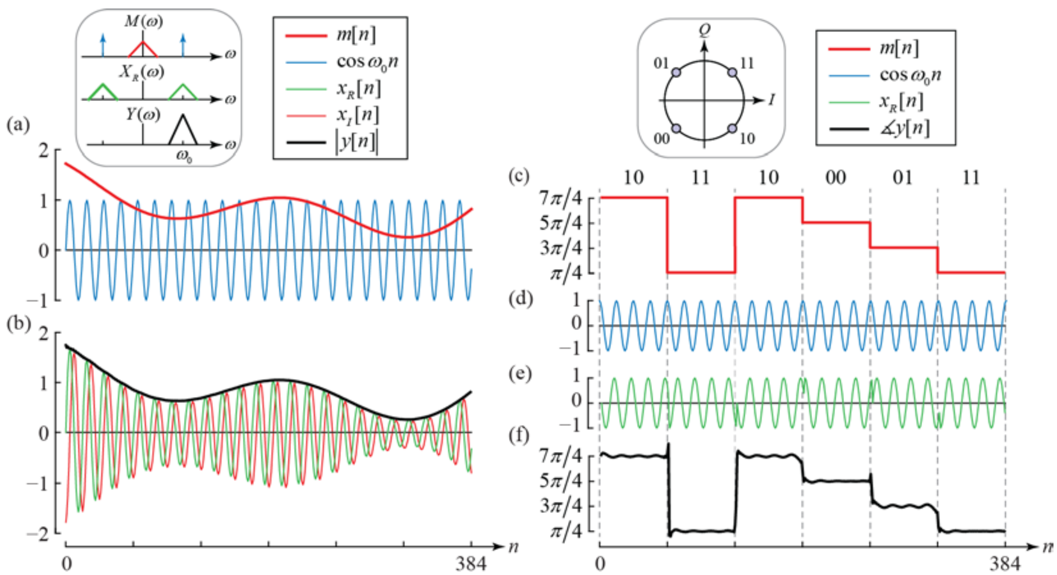
452 Equation 7.17 is wrong:

$$H(\omega) = \frac{1}{2\pi} H_0(\omega) * R(\omega) = \begin{cases} 1, & |\omega| < \omega_c - \Delta\omega/2 \\ \frac{1}{2} - \frac{1}{2}\sin\frac{\pi(\omega-\omega_c)}{\Delta\omega}, & \omega_c - \Delta\omega/2 < |\omega| < \omega_c + \Delta\omega/2 \\ 0, & |\omega| > \omega_c + \Delta\omega/2 \end{cases}$$

458/3 up Last line of equation is wrong.

$$H(\omega) = \sum_{n=0}^{N-1} h[n]e^{-j\omega n} = \sum_{n=0}^{N-1}\left(\frac{1}{N}\sum_{k=0}^{N-1} H[k]e^{j2\pi kn/N}\right)e^{-j\omega n} = \frac{1}{N}\sum_{k=0}^{N-1} H[k]\sum_{n=0}^{N-1} e^{-j(\omega-2\pi k/N)n}$$
$$= \frac{1}{N}\sum_{k=0}^{N-1} H[k]\frac{1-e^{-j(\omega-2\pi k/N)N}}{1-e^{-j(\omega-2\pi k/N)}} = \frac{1}{N}\sum_{k=0}^{N-1} H[k]e^{-j(\omega-2\pi k/N)((N-1)/2)}\frac{\sin(\omega-\frac{2\pi k}{N})\frac{N}{2}}{\sin(\omega-\frac{2\pi k}{N})\frac{1}{2}}$$

480 Figure 7.44b. The constellation diagram is wrong. Reading CCW, the order should be 11, 01, 00, 10.



480/7 et. seq The first display equation on the page should be

$$x_I[n] = m[n]\sin\omega_0 n$$

The second equation should be

$$|y[n]| = \sqrt{x_R^2[n] + x_I^2[n]} = \sqrt{(m[n]\cos\omega_0 n)^2 + (m[n]\sin\omega_0 n)^2} = \sqrt{m^2[n]}\sqrt{\cos^2\omega_0 n + \sin^2\omega_0 n}$$
$$= |m[n]|$$

514/14 Line above Equation (8.26) should read, “Because $\cos x = \cosh(jx)$ and $\cos^{-1} x = j\cosh x$ …”

517/5 Sentence should read, “From the degree equation, Equation (8.28), we could also calculate the revised selectivity factor...”

518/4 up “The minor (real) axis of the ellipse is determined by $\cosh\varphi$ and the major (imaginary) axis by $\sinh\varphi$.”

519 Equations (8.32b) isn't wrong; it just could be a bit clearer:

$$K = |H(\omega=0)| = \frac{1}{\sqrt{1+\varepsilon_p^2 T_N^2(0)}} = \begin{cases} 1\big/\sqrt{1+\varepsilon_p^2}, & N \text{ even} \\ 1, & N \text{ odd} \end{cases}.$$

525/1 up Equation (8.41) Parenthesis missing in numerator

$$R_N(\xi, x) = \mathrm{cd}\left(\left(N\frac{K(1/L(\xi))}{K(1/\xi)}\right)\mathrm{cd}^{-1}(x, 1/\xi)\right)$$

529/7 "…selectivity factor ξ for a filter…"

544/1 up The first word on the last line on page should be "integrator" not "differentiator"

559/9 up Cosmetic

$$H(z) = \frac{0.0156(1+5z^{-1}+10z^{-2}+10z^{-3}+5z^{-4}+z^{-5})}{1-1.5097z^{-1}+2.1610z^{-2}-1.8229z^{-3}+1.0800z^{-4}-0.4083z^{-5}}$$

559/1 up It's probably best to split the scale factors between the sections:

$$H(z) = \frac{0.45755(1+2z^{-1}+z^{-2})}{1-0.062544z^{-1}+0.89273z^{-2}} \cdot \frac{0.22653(1+2z^{-1}+z^{-2})}{1-0.74867z^{-1}+0.6548z^{-2}} \cdot \frac{0.15076(1+z^{-1})}{1-69847z^{-1}}$$

566/1 up Put scale factor at the beginning:

$$H(z) = \frac{0.0102(1+4z^{-1}+6z^{-2}+4z^{-3}+z^{-4})}{1-1.9684z^{-1}+1.7359z^{-2}-0.7245z^{-3}+0.1204z^{-4}}$$

570/4 Put scale factor at the beginning

$$H(z) = \frac{0.0102(1-4z^{-1}+6z^{-2}-4z^{-3}+z^{-4})}{1+1.9684z^{-1}+1.7359z^{-2}+0.7245z^{-3}+0.1204z^{-4}}$$

573/1 up In Equation (8.78a), it should be $H_{bs}(z)$, not $H_{bp}(z)$

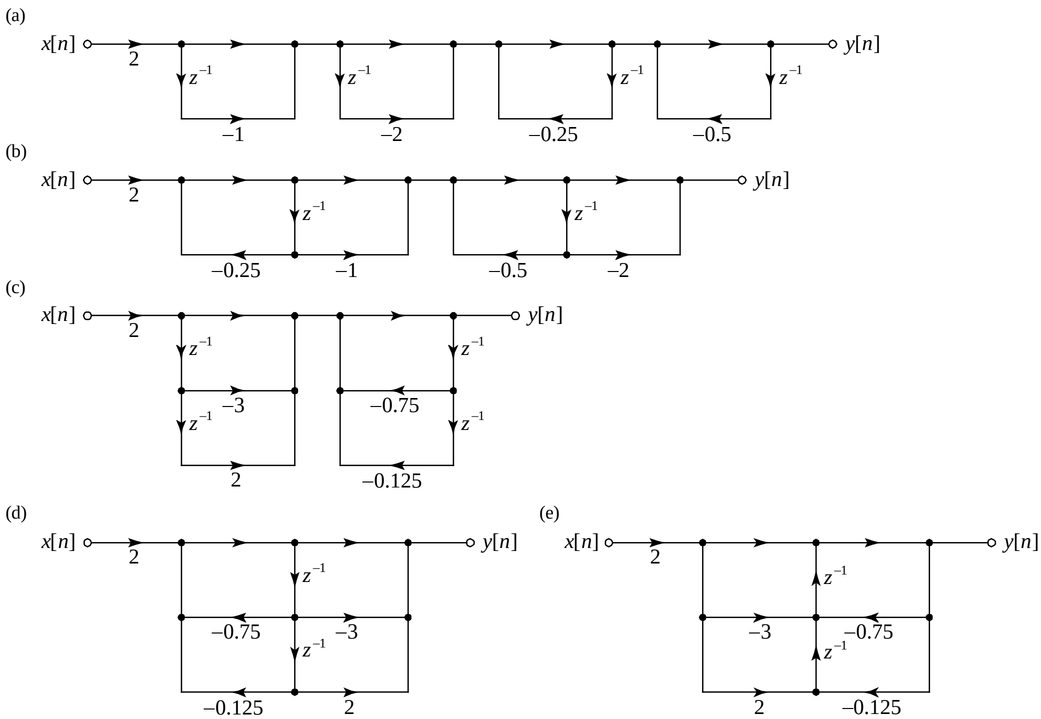
574/9 up In the display equation, it should be $H_{bs}(z)$, not $H_{bp}(z)$.

602/12 up In the second display equation from the bottom, $W(z)$ in the numerator should have been crossed out:

$$H(z) = \frac{Y(z)}{X(z)} = \underbrace{\frac{\cancel{W(z)}}{X(z)}}_{H_1(z)} \cdot \underbrace{\frac{Y(z)}{\cancel{W(z)}}}_{H_2(z)} = \underbrace{\left(\sum_{k=0}^{N} b_k z^{-k}\right)}_{H_1(z)} \underbrace{\left(\frac{1}{1+\sum_{k=1}^{N} a_k z^{-k}}\right)}_{H_2(z)}$$

604/6 up The last term of the in-line equation should be $z^{-1}Q_2(z)$, not $z_{-1}Q_2(z)$: $Q_1(z) \triangleq \left(b_1 X(z) - a_1 Y(z)\right) + z^{-1}Q_2(z)$

607 Figure 9.10 The signs of the feedforward terms in parts a and b are wrong. They should be negative.



617 Equation (9.15) $G_i(z)$ instead of $G_k(z)$ on the second line

$$F_i(z) = F_{i-1}(z) + k_i z^{-1} G_{i-1}(z)$$
$$G_i(z) = k_i F_{i-1}(z) + z^{-1} G_{i-1}(z)$$

623/11 Should be a_1 in last term

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{A_1(z)} = \frac{1}{1+k_1 z^{-1}} = \frac{1}{1+a_1 z^{-1}}$$

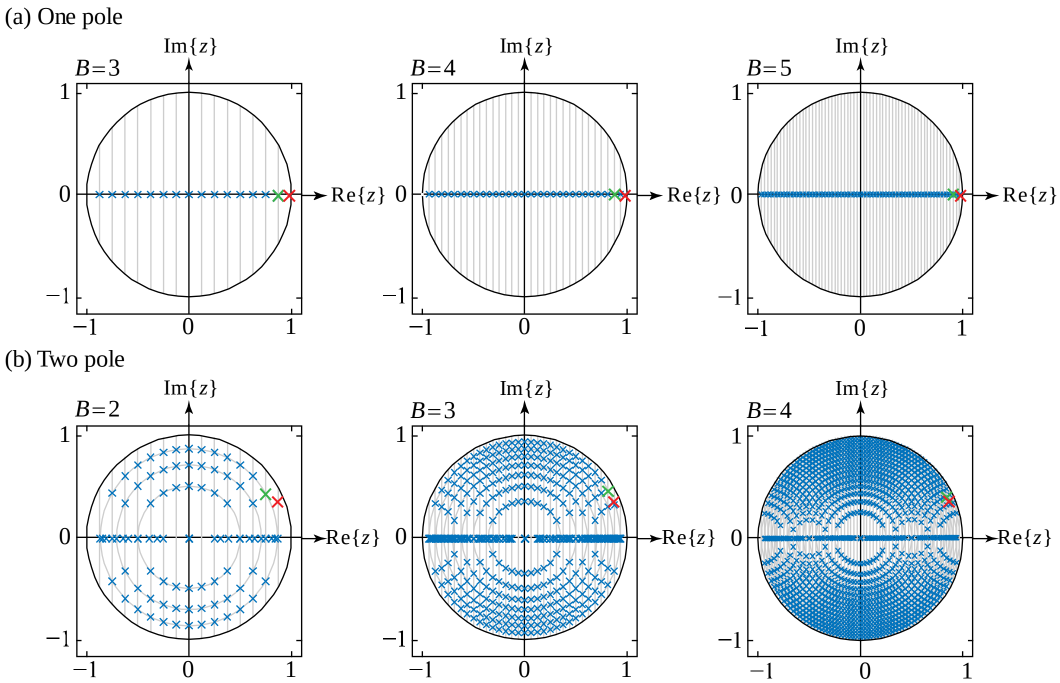
623/15 Several errors: 2nd and 6th lines

$$\begin{aligned} V_2(z) &= V_1(z) + k_2 z^{-1} W_1(z) \\ &= \left(V_0(z) + k_1 z^{-1} W_0(z)\right) + k_2 z^{-1} W_0(z)\left(k_1 + z^{-1}\right) \\ &= V_0(z)\left(1 + k_1(1+k_2) z^{-1} + k_2 z^{-2}\right) \\ W_2(z) &= k_2 V_1(z) + z^{-1} W_1(z) \\ &= k_2 V_0(z)\left(1 + k_1 z^{-1}\right) + z^{-1} W_0(z)\left(k_1 + z^{-1}\right) \\ &= W_0(z)\left(k_2 + k_1(1+k_2) z^{-1} + z^{-2}\right) \end{aligned}$$

623/8 up

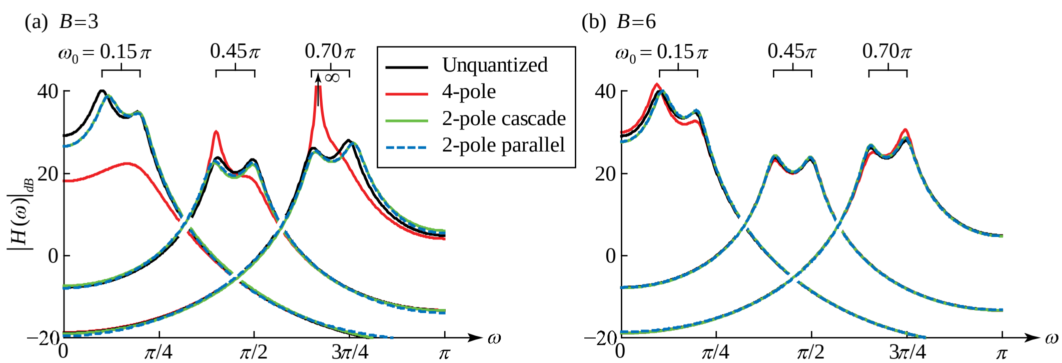
$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{A_2(z)} = \frac{1}{1 + k_1(1+k_2) z^{-1} + k_2 z^{-2}} = \frac{1}{1 + a_1 z^{-1} + a_2 z^{-2}}$$

631 Figure 9.23b: there should be more poles on real axis. Here is the revised figure:



635/2 “…where the discriminant is negative, $a_1^2 - 4a_2 < 0$.”

636 Figure 9.27 missing a black line in the legend for ‘Unquantized’



658/6 $x[n] = \mathbb{F}_N^{-1}\{X[k]\} \triangleq \dfrac{1}{N}\sum_{k=0}^{N-1} X[k]e^{j2\pi kn/N},\ 0 \le n \le N-1$

675/2 The sign of last term on second line of the big equation is wrong. The legends $x_1[n]$, $x_2[n]$, $x_3[n]$ and $x_4[n]$ are also in the wrong order.

$$
\begin{aligned}
x[n] &= \frac{1}{8}\left\{ X[0] + X[4](-1)^n + 2\sum \left|X[k]\right| \cos\left(\pi kn/4 + \measuredangle X[k]\right) \right\} \\
&= 0.375 + 0.125(-1)^n + 0.60\cos\left(\pi n/4 - \pi/4\right) + 0.25\cos\left(\pi n/2 - \pi/2\right) + 0.10\cos\left(3\pi n/4 + \pi/4\right) \\
&= \underbrace{0.375}_{x_0[n]} + \underbrace{0.125(-1)^n}_{x_4[n]} + \underbrace{0.60\cos\left(\pi(n-1)/4\right)}_{x_1[n]} + \underbrace{0.25\cos\left(\pi(n-1)/2\right)}_{x_2[n]} - \underbrace{0.10\cos\left(3\pi(n-1)/4\right)}_{x_3[n]}
\end{aligned}
$$

680/5 $y[n]=\mathbb{F}_N^{-1}\left\{Y[k]\right\}=2\delta[n]+\delta[n-1]+\delta[n-3]$

730/9 Equation (11.13) et seq. Should use $\mathbb{F}_N$ instead of $\mathfrak{F}$

$$x[n]=\mathbb{F}_N^{-1}\{X[k]\}=\frac{1}{N}\sum_{k=0}^{N-1}X[k]e^{j2\pi kn/N}$$

730/11 Same

$$X[k]=\mathbb{F}_N\{x[n]\}=\sum_{n=0}^{N-1}x[n]e^{-j2\pi kn/N}$$

732/18 Same: $X[k]=\mathbb{F}_N\{x[n]\}$

732/20 Same:

$$\begin{aligned}\mathbb{F}_N\{x^*[n]\}&=\sum_{n=0}^{N-1}x^*[n]e^{-jk2\pi n/N}=\left(\sum_{n=0}^{N-1}x[n]e^{jk2\pi n/N}\right)^*=\left(\sum_{n=0}^{N-1}x[n]e^{-j(-k)2\pi n/N}\right)^*\\&=X^*[(-k)_N]=X^*[N-k]\end{aligned}$$

732/23 "Hence, $\mathbb{F}_N\left\{x^*[n]\right\}=\mathbb{F}_N\left\{x[n]\right\}$, so …"

734/5 Equation (11.15)

$$\begin{aligned}X_1[k]&\triangleq\mathbb{F}_N\{x_1[n]\}=\mathbb{F}_N\left\{\tfrac{1}{2}(x[n]+x^*[n])\right\}=\tfrac{1}{2}(X[k]+X^*[N-k])\\X_2[k]&\triangleq\mathbb{F}_N\{x_2[n]\}=\mathbb{F}_N\left\{\tfrac{1}{2j}(x[n]-x^*[n])\right\}=\tfrac{1}{2j}(X[k]-X^*[N-k])\end{aligned}$$

738/14 up Cosmetic replace IFFT with $\mathbb{F}_N^{-1}$

$$\left.\begin{aligned}x_1[n]&=\frac{1}{2}\left(\frac{1}{N/2}\sum_{k=0}^{N/2-1}X_1[k]W_{N/2}^{-kn}\right)=\tfrac{1}{2}\mathbb{F}_{N/2}^{-1}\{X_1[k]\}\\x_2[n]&=\frac{1}{2}\left(\frac{1}{N/2}\sum_{k=0}^{N/2-1}X_2[k]W_{N/2}^{-kn}\right)=\tfrac{1}{2}\mathbb{F}_{N/2}^{-1}\{X_2[k]\}\end{aligned}\right.\quad,\quad 0\le n<N/2$$

738/10 up Cosmetic replace IFFT with $\mathbb{F}_N^{-1}$

$$\underbrace{\tfrac{1}{2}\mathbb{F}_{N/2}^{-1}\{X[k]\}}_{x[n]}=\underbrace{\tfrac{1}{2}\mathbb{F}_{N/2}^{-1}\{X_1[k]\}}_{x_1[n]}+\underbrace{j\tfrac{1}{2}\mathbb{F}_{N/2}^{-1}\{X_2[k]\}}_{jx_2[n]}$$

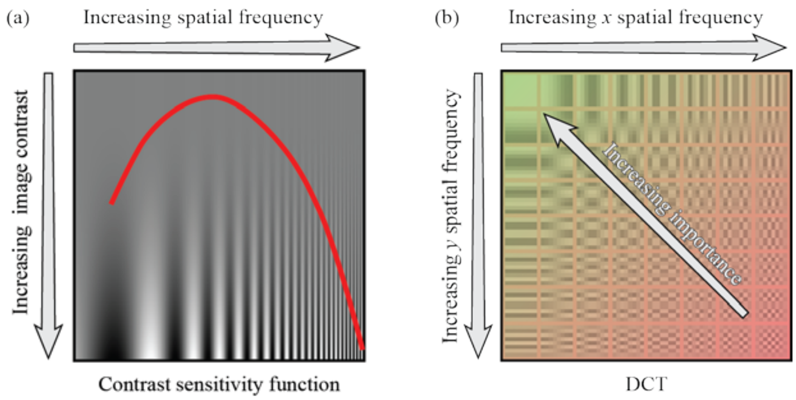
739/14 `disp('ifft(X[k]) x[n]'), disp([xx' x'])`

740/11 up "frequencies $2\pi k/8$, …"

740/1 up Should be $(2k)$ in first summation

$$Y[k] = X[2k] = \sum_{n=0}^{N-1} x[n]e^{-j2\pi(2k)n/N} = \sum_{n=0}^{2(N/2)-1} x[n]e^{-j2\pi kn/(N/2)} = \sum_{n=0}^{2M-1} x[n]e^{-j2\pi kn/M}$$

798 Figure 12.16a is missing the contrast sensitivity function (the red curve_



987/8 Code should be isa(s, 'sequence')