Medical Imaging Signals and Systems

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This errata applies to both the first and second printings of the book. The printing number can identified by looking on the copyright page (on the back of the title page) and finding either of the following:

This is the first printing:
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In the items below, entries starting with an asterisk are errors that should be corrected. Entries that start with a bullet are either typographical corrections or corrections related to clarity. Some corrections were made in the second printing; if so, the item is given the notation "1st printing only."

Preface

- **Page xv:** The first words of the last paragraph should read "Part III presents the physics ..."

Part I: Basic Imaging Principles

- **Page 4:** The figure references in the parenthetical sentence on lines 5 and 6 should be I.1(d) and I.1(c).

Chapter 2: Signals and Systems

* **Page 41:** In EXAMPLE 2.9, on the top line of the page, the relationship between U and V should be: $0 < V \leq U$.

* **Page 43:** Figure 2.11 should look like this:

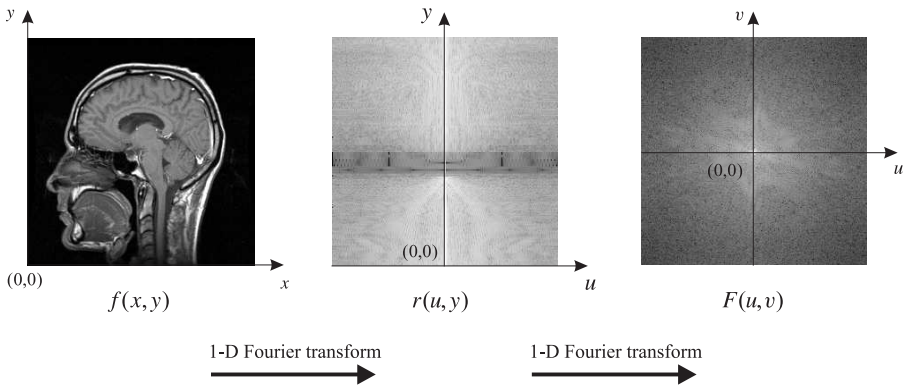
- **Page 52:** In the second line in Section 2.8.2, the word "rect" should be "rectangle."

Chapter 3: Image Quality

- **Page 66:** In Equation (3.6), there is a missing subscript on the variable u. Equation (3.6) should be:

$$m_g = \frac{B|H(u_0,0)|}{AH(0,0)} = m_f \frac{|H(u_0,0)|}{H(0,0)} \tag{3.6}$$

* **Page 84:** In the Answer to Example 3.8, the first line has an incorrect interval. It should read $t < T < t + \Delta t$.



* **Page 84:** In the Answer to Example 3.8, the fifth displayed equation (not numbered) ends with the symbol Δ. There should be a t after the symbol, yielding $\lambda \Delta t$ on the right hand side of that particular equation.

* **Page 85:** The very last equation on this page should read:

$$p_S(\eta) = \frac{1}{\sqrt{2\pi\sigma_S^2}} \exp\left\{\frac{-\eta^2}{2\sigma_S^2}\right\} = \frac{1}{\sqrt{4\pi\sigma^2}} \exp\left\{\frac{-\eta^2}{4\sigma^2}\right\}$$

* **Page 88:** The last part of (3.67) should be multiplied by $H^2(0,0)$. In otherwords, it should be:

$$\text{SNR}_p(u,v) = \frac{|H(u,v)|^2 |F(u,v)|^2}{\text{NPS}(u,v)} = \frac{\text{MTF}^2(u,v)}{\text{NPS}(u,v)} |F(u,v)|^2 H^2(0,0) \tag{3.67}$$

* **Page 94:** In EXAMPLE 3.13, the Specificity should be equal to 1.0.

- **Page 96:** The second displayed impulse response function in Problem 3.3 should be $h_2(x)$.

- **Page 97:** The wording in 3.11(c) needs improvement. It should read: (c) Derive a relation between the contrast of the output image and the bar separation and draw a conclusion about the resolution of the imaging system.

- **Page 99:** The first sentence of Problem 3.22 should read: Suppose the probability law of a test result for patients with and without a disease are modeled as Gaussian with different ..." The fourth sentence should say "…we call it diseased." Part (a) should read: "Write down the expressions for the probability density functions of the test value ..."

- **Page 100:** The caption for Figure P3.3 should read: "Probability density functions showing the test results for normal subjects and patients with disease."

Chapter 4: Physics of Radiography

- **Page 114: (1st printing only)** Table 4.3 should be modified as shown.

- **Page 133: (1st printing only)** On the fourth line from the top, Kg should be kg (not capitalized).

- **Page 133: (1st printing only)** In Problem 4.7, Kg should be kg (not capitalized) in three places.

Table 4.3 Radiation Concepts

	Imaging	Dose
Particulate	Bremsstrahlung Characteristic radiation *Positron annihilation** *Range*	Linear energy transfer Specific ionization
Electromagnetic	Attenuation Photoelectric effect Compton scatter Characteristic radiation Polyenergetic	Air kerma Dose Dose equivalent Effective dose f-factor

*Italicized entries are discussed in Chapter 7.

Chapter 5: Projection Radiography

- **Page 138: (1st printing only)** In Figure 5.5, Bremsstrahlung is misspelled
- **Page 156:** In the third and fourth displayed equations, μ should be replaced by μ_α.
- * **Page 160: (1st printing only)** Equation (5.26) should read

$$k \propto \frac{1}{m^2(z)} \,. \tag{5.26}$$

- * **Page 160: (1st printing only)** Equation (5.27) should read

$$\frac{s(x/m,\, y/m)}{m^2} \rightarrow S(0,0)\delta(x,\, y) \,. \tag{5.27}$$

- **Page 164: (1st printing only)** Figure 5.22 should be modified as shown.
- **Page 164:** In the first line of text (below Fig 5.22), there is an extra word "it" after the comma.
- **Page 174:** There should be a line break after the first sentence of problem 5.19, part (a).
- **Page 174:** The last line of the page should read: 0.15 cm^{-1} at 75 keV.

Chapter 6: Computed Tomography

- **Page 186:** In the second paragraph under **Answer**, in the second line, the first few words should read "increment is $180^\circ/360 = 0.5^\circ$ …"
- **Page 203:** On the second line, the word "it" should be "its."
- * **Page 207:** Equation (6.38) should read:

$$c(D' \sin\gamma) = \left(\frac{\gamma}{D' \sin\gamma}\right)^2 c(\gamma) \tag{6.38}$$

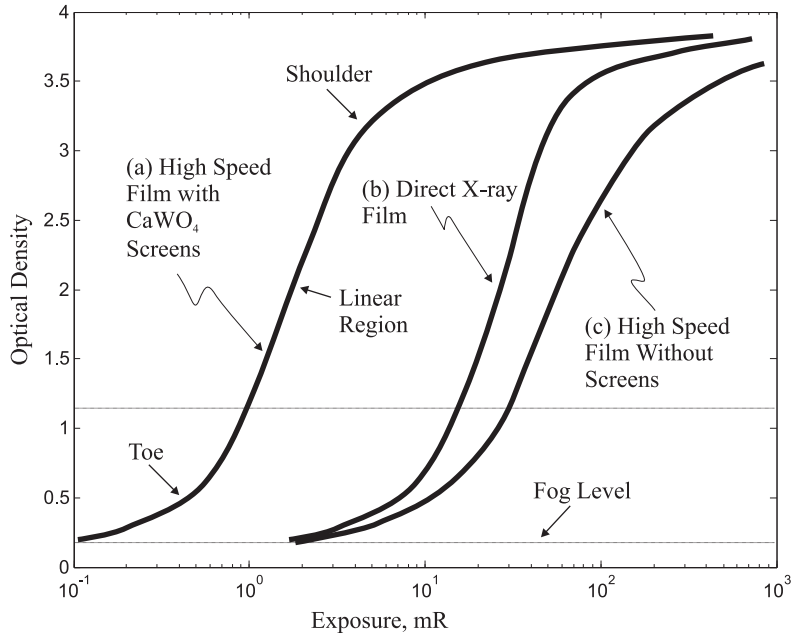


Figure 5.22 An H&D curve.

* **Page 207:** Equation (6.39) should read:

$$c_f(\gamma) = \frac{1}{2} D \left(\frac{\gamma}{\sin \gamma} \right)^2 c(\gamma) \tag{6.39}$$

* **Page 207:** In Equations (6.40) and (6.41) put a tilde over both p's as follows: $\tilde{p}(\gamma, \beta)$. Then add these words after equation (6.40): where $\tilde{p}(\gamma, \beta) = \cos \gamma p(\gamma, \beta)$.

• **Page 210:** There is an extra closed parenthesis in equation (6.49), which should read:

$$\mathcal{R}\{f * h\} = \mathcal{R}\{f\} * \mathcal{R}\{h\} \tag{6.49}$$

* **Page 210:** The sentence immediately after equation (6.49) should read: Notice that the convolution on the left in (6.49) is two-dimensional, while that on the right is one-dimensional.

• **Page 212:** The first equation has a typo; it should read:

$$\mathcal{H}\{f(ar)\} = \frac{1}{a^2} F(q/a)$$

* **Page 216:** On the line before equation (6.77), the substitution should be $d = L/D$, not $w = L/D$.

• **Page 216:** In the 4th line of EXAMPLE 6.6, the word "contract" should be "contrast."

* **Page 216:** The second to the last equation should read:

$$\sigma_\mu^2 = 5.625 \times 10^{-9}\ \text{cm}^{-2} = \frac{2\pi^2}{3}\frac{\varrho_0^3 T}{M\overline{N}}$$

* **Page 217:** The answer to EXAMPLE 6.6 should be

$$1.87 \times 10^{10}\ \text{minimum}$$

- **Page 220:** The word "simply" in Problem 6.5 should be "simplify."
- **Page 220:** There is an extra closed parenthesis in the displayed equation in problem 6.9. It should read

$$\mathcal{R}\{f * h\} = \mathcal{R}\{f\} * \mathcal{R}\{h\}$$

- **Page 223:** In problem 6.16(d), there should only be one * for the convolution (to stay with convention in the book).

* **Page 223:** In problem 6.18, the displayed equation should read:

$$c(D' \sin\gamma) = \left(\frac{\gamma}{D' \sin\gamma}\right)^2 c(\gamma)$$

Chapter 7: The Physics of Nuclear Medicine

- **Page 249: (1st printing only)** The second line of the Early reference should be indented.

* **Page 251:** In Problem 7.8(a), the DF equation should read

$$\text{DF} = e^{-0.693t/T_{1/2}}$$

Chapter 8: Planar Scintigraphy

- **Page 255:** The very last sentence on this page should start: "For every 4 to 5 light"
- **Page 259:** There should be a question mark at the end of the question in Example 8.2.
- **Page 261:** On the very first line, the word "tomography" should have a period after it instead of a comma.

* **Page 269:** On the second line below equation (8.12), the variable r should be replaced by $|z|$.

* **Page 270:** The first equation on the page should read:

$$R_C = \frac{d}{l}(l + b + r) = d + \frac{b + r}{l}d\,.$$

The second equation should read:

$$R'_C = \frac{d}{2l}(2l + b + r) = d + \frac{b + r}{2l}d < R_C\,.$$

* **Page 280: (1st printing only)** The fourth line of Problem 8.4 should read: A is at a distance of r from the camera, directly below the hole.

* **Page 283: (1st printing only)** The fourth line of the page (within problem Problem 8.10) should read: ratio in the last image?

Chapter 9: Emission Computed Tomography

- **Page 295:** In the 7th text line from the bottom, it should read: "to coincide with the x-axis when"
- **Page 297: (1st printing only)** The arrow next to θ in Figure 9.7 should point in the other direction.
- **Page 299:** Third paragraph, 5th line. The sentence should begin: "This means that there will be N_0 gamma ray…"
- **Page 310:** The caption of Figure P9.1 should read: Problem 9.1.
- **Page 310:** Figure P9.1. The righthand crystal should be labelled C(4,6).
- **Page 310:** Problem 9.1(b) should read: "Find the numerical responses in each PMT to an event…"

Chapter 10: The Physics of Ultrasound

- **Page 321:** In example 10.2, second sentence: replace "At time" with "Starting at time".
- **Page 321:** In the paragraph after the start of section 10.2.3, the reference to Problem 10.2 should be: (see Problem 10.4).

* **Page 321:** In the last line of text, the inward-traveling wave should be given by $\phi_i(t + c^{-1}r)$.

- **Page 323:** Put immediately after (10.23) the following text: where c_1 and c_2 are the speeds of sound in Medium 1 and Medium 2, respectively.

* **Page 324: (1st printing only)** The numbers in the answer to Example 10.3 (at the top of the page) are wrong. It should read as follows:

  Answer: $\theta_r = \theta_i = 45^\circ$. Since $c_1 = 1450$ m/s and $c_2 = 1570$ m/s,

  $$\sin\theta_t = \frac{1570 \sin 45^\circ}{1450} = 0.7656\,.$$

  Solving this yields $\theta_t = 49.96^\circ$. It makes intuitive sense that the transmission angle should be larger than the incidence or reflection angle, since $c_2 > c_1$.

* **Page 325, Example 10.4: (1st printing only)** The computed value for R_I should be 0.0106, (the square of 0.103). Accordingly, the sentence after should read: "Only about 1 percent of the incident power is reflected back from the interface; about 99 percent is transmitted through."

* **Page 327, Example 10.5: (1st printing only)** Because of the above error in Example 10.4, there is an error in this example as well. The last part of the example should read:

  From the previous example, we know that the intensity reflectivity is 0.0106. The amplitude reflectivity is therefore $\sqrt{0.0106} = 0.103$. Putting these facts together yields

  $$\text{dB loss} = 20\log_{10}\frac{A_z}{A_0} = 20\log_{10}(0.234 \times 0.103) = -32.4\text{ dB}\,.$$

* **Page 332:** Equation (10.48) should read:

$$f_D = \frac{2v\cos\theta}{c} f_S \tag{10.48}$$

- **Page 335:** In the first line of text, the word "is" should be "are."

* **Page 335:** The first "n" in equation (10.51) is set in the wrong font. The equation should read:

$$\mathrm{n}(t) = \tilde{n}(t)e^{-j2\pi f_0 t} \tag{10.51}$$

- **Page 344, 10.9(b):** plan should be plane

- **Page 352:** The last line of the Question in Example 11.2 should read: sound is $c = 1540$ m/s, what is the maximum rate of revolution of the transducer?

* **Page 352:** The last equation should read:

$$T = 2 \times \frac{15 \text{ cm}}{1540 \text{ m/s}} = 195 \ \mu\text{s}$$

- **Page 360:** Remove the expression "as shown in this figure" from the last line of Section 11.5.2.

Chapter 12: Physics of Magnetic Resonance

- **Page 385:** In the last line of text, the equation reference should be (12.8).

- **Page 405:** In the second line of text, the word vector should be plural: vectors.

- **Page 405:** In problem 12.4, the word envelope is mispelled (it is missing the last "e").

Chapter 13: Magnetic Resonance Imaging

* **Page 437:** In the first equation appearing in Example 13.7, there should be a 2π in the second exponential term, right before γ.

* **Page 442: (1st printing only)** In equation (13.48), there should be a space between the square root symbol and symbol t, as follows:

$$\varrho = \gamma\sqrt{G_x^2 + G_y^2}\ t\,. \tag{13.48}$$

* **Page 443:** Equation (13.52) should read

$$G(\varrho,\theta) = s_0\left(\frac{\varrho}{\gamma\sqrt{G_x^2+G_y^2}},\theta\right)\,. \tag{13.52}$$

- **Page 457:** After the last sentence of Problem 13.7, add another sentence in parenthesis as follows: (Assume that the pulse sequence in Figure 13.15 is used.)

* **Page 459:** The duration of the gradient pulse in Figure P13.5 should be NT.

- **Page 459: (1st printing only)** In problem 13.12, part (a), there should be a circle around the number 2 (as in Figure 13.20).

- **Page 460:** In Problem 13.16, the word “in” in the first sentence should be “is”.