Errata

Signals, Systems, Transforms and Digital Signal Processing with MATLAB©

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Back cover

First sentence should read:

Signals, Systems, Transforms, and Digital Signal Processing with MATLAB® has as its principal objective *simplification without compromise of rigor*. Graphics, called by the author 'the language of scientists and engineers', physical interpretation of subtle mathematical concepts, and a gradual transition from basic to more advanced topics are meant to be among the important contributions of this book

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Preface

First sentence should read:

Simplification without compromise of rigor is the principal objective in this presentation of the subject of signal analysis, systems, transforms and digital signal processing. Graphics, the language of scientists and engineers, physical interpretation of subtle mathematical concepts and a gradual transition from basic to more advanced topics, are meant to be among the important contributions of this book.

Chapter 1

Page 12 Fig. 1.17 (c):

Erase foreign diagonal line inadvertently added on electric circuit.

Page 16

Second paragraph

Should read:

In evaluating the convolution integral, as in Equation (1.30),

Page 28

Example 1.21 *Given the sequence $h[n]$ defined by $h[n] = (1 + n^2)u[n] + e^{\alpha n}u[-n]$ with $\alpha > 0$, evaluate and sketch its even and odd parts.*

We have, as depicted in Fig. 1.36.

$$h_e[n] = (1/2)\left[1 + n^2 + e^{-\alpha|n|}\right] + \delta[n] \qquad (1.65)$$

Page 29

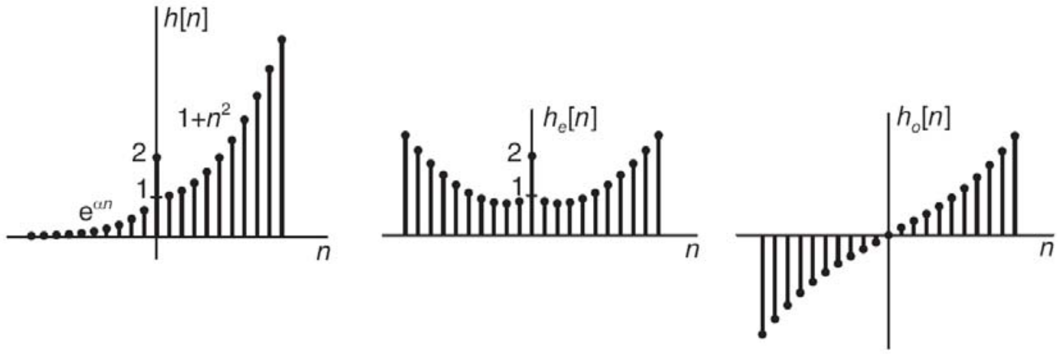


FIGURE 1.36 Even and odd parts of a general sequence.

Page 32

Probs 1.11 and 1.12

Replace

inverted !

by

<

Prob 1.23

a) **A system has an impulse response ….**

b) **Evaluate the convolutions ….**

Problem 1.34

y(t) = R_{2}(t) **= …**

Problem 1.42 page 37

Part c)

Replace

$v_2(t-10n)$

by

$v_b(t-10n)$

Chapter 3

Page 124

Example 3.20

Should read

Example 3.20 *Evaluate the Laplace transform of the causal periodic ramp*

$$v(t) = \sum_{n=0}^{\infty} v_0(t-nT)$$

where $v_0(t) = A(t/T)R_T(t)$ *and* $R_T(t) = u(t) - u(t-T)$.

Page 150

Problem 3.13 a) $h(t) = e^{-t}u(t)$; b) $h(t) = -e^{-t}u(t) + \delta(t)$; d) $h(t) = 1.5e^{-4t}u(t) - 0.5e^{-2t}u(t)$; e) $h(t) = 0.8e^{-2t}u(t) - 1.2e^{+3t}u(-t)$; f) $h(t) = te^{-t}u(t)$; g) $h(t) = -e^{-t}u(t) + te^{-t}u(t) + e^{-2t}u(t)$

Chapter 4

Page 173

$$\frac{W}{2\pi}\left[Sa\left(\frac{Wt}{2}\right)\right]^2 \qquad \Big| \qquad \Lambda_W(\omega)$$

Problem 4.6

Let f(t) be a periodic signal of period …

Evaluate the Fourier series coefficients and the Fourier transform over the interval (-1, 1) of

a) f(t),

b) the causal function g(t) = …

Problem 4.23

Let x(t) …

Let the signal y(t) be a periodic signal …

Problem 4.24

b) … Evaluate the **Fourier** transform …

Chapter 5

Problem 5.15

The following, part c), would be a good addition to the book problem.

c) For cases a) and b) above find the continuous-time functions f_1(t) and f_2(t) which when ideally sampled would produce the signals x(t) and v(t), respectively, and write the outputs y_1(t) and y_2(t) as functions of f_1(t) and f_2(t) and the shifted versions of the step function u(t).

Prblem 5.22

For the d-c current motor shown in Fig. 5.82 assuming a

constant voltage E_{e} in the inductor circuit, a negligible

inductance of the armature circuit and negligible load …

Chapter 6

Page 323

Last paragraph

Replace

$\sin(\gamma t)$

by

$\sin(\gamma n)$

Page 349

Eq. (6.91)

Should read

$$H(z) = \frac{Y(z)}{X(z)} = \frac{\sum_{k-0}^{M} b_k z^{-k}}{\sum_{k=0}^{N} a_k z^{-k}} = \frac{\sum_{k-0}^{M} b_k z^{-k}}{1 + \sum_{k=1}^{N} a_k z^{-k}}$$

Eq. (6.97)

Replace

$$\frac{\sum_{k=0}^{N} b_k e^{-j\Omega k}}{1 + \sum_{k=1}^{M} a_k e^{-j\Omega k}}$$

by

$$\frac{\sum_{k=0}^{M} b_k e^{-j\Omega k}}{1+\sum_{k=1}^{N} a_k e^{-j\Omega k}}$$

Section 6.24 Two-Dimensional Signals

Page 364

Equation (6.153) should read

$$n_1 n_2 x[n_1,\ n_2] \longleftrightarrow z_1 z_2 \frac{d^2 X(z_1,\ z_2)}{dz_1 dz_2} \qquad (6.153)$$

Page 365

Unit Step 2DSequence

Equation (3.162)

Should read:

$$u[n_1, n_2] = \begin{cases} 1, & n_1, n_2 > 0 \\ 0, & n_1, n_2 < 0. \end{cases}$$

Page 366

Causal Exponential

Equation (3.163)

Should read:

$$x[n_1, n_2] = \begin{cases} a_1^{n_1} a_2^{n_2}, & n_1, n_2 > 0 \\ 0, & n_1, n_2 < 0. \end{cases}$$

Page 379

Before Fig. 645

Eraze redundant

the unit

Chapter 7

Page 397

before We note that

-1/2 is missing. Should read

$$V(z) = \sum_{n=0}^{\infty} e^{-\alpha n T} z^{-n} - \frac{1}{2} = \dots$$

Page 402

Line before last:

Replace

=1/2 +/4=

by

=1/2 +1/4=

Page 413

Correct to read

Example 7.5 *A sequence $x[n]$ is bandlimited such that*

$$X(e^{j\Omega}) = 0, \quad 0.23\pi < |\Omega| < \pi.$$

Page 415

Fig. 7.18 and Fig. 7.19

Replace

K

by

L

Equation (7.100):

Replace

K

by

L

Example 7.6

Replace

$\cos(5000t)$

by

$\cos(5000\pi t)$

Page 416

Example 7.7

Replace

$$h[n] = KSa[\pi(n-m)/M]$$

by

$$h[n] = KSa[\pi(n-m)/L]$$

Before Equation (7.101)

Replace

. Evaluate the system output

by

, evaluate the system output

After Equation (7.101)

Replace

$KL\Pi_{\pi/L}$

by

$K\Pi_{\pi/L}$

Page 417

Sec. 7.8.3

Replace

F=K/M

by

$F=L/M$

Example 7.8 should read:

Example 7.8 *As noted above, a DAT recorder operates at a sampling frequency of* 48 *kHz. We need to transfer to a DAT the contents of a CD player, which operates at a frequency of* 44.1 *kHz. Show how to perform the rate conversion.*

Page 425

Equation (7.107)

In RHS replace

πT

by

π / T

Page 432

Should read

The student can verify that $X\left(e^{j\Omega}\right)$ *can be written in the form*

$$X\left(e^{j\Omega}\right) = 0.5\left\{e^{-j(\Omega-B)(N-1)/2} Sd_N\left[(\Omega-B)/2\right] + e^{-j(\Omega+B)(N-1)/2} Sd_N[(\Omega+B)/2]\right\}$$

where the Sd_N *function can be seen in the Appendix Sec.(A.1). Alternatively, we may write*

$$X\left(e^{j\Omega}\right) = \frac{N}{2}\left\{\Phi\left(\Omega-B\right)+\Phi\left(\Omega+B\right)\right\}$$

where

$$\Phi\left(\Omega\right) = \frac{\sin\left(N\Omega/2\right)}{N\sin\left(\Omega/2\right)}\ e^{-j(N-1)\Omega/2}.$$

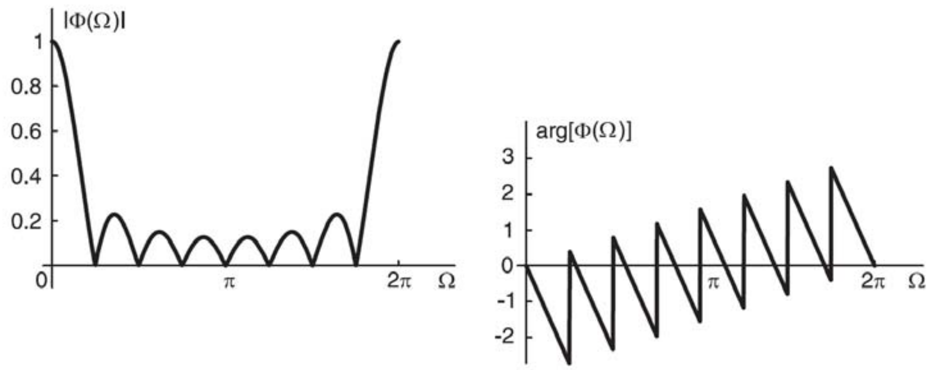


FIGURE 7.31 The function $\Phi(\Omega)$.

Page 448 last paragraph

Should read:

Note: The properties listed in Table 7.3 are those of the DFS….

Page 475

Fig. 7.56 should be:

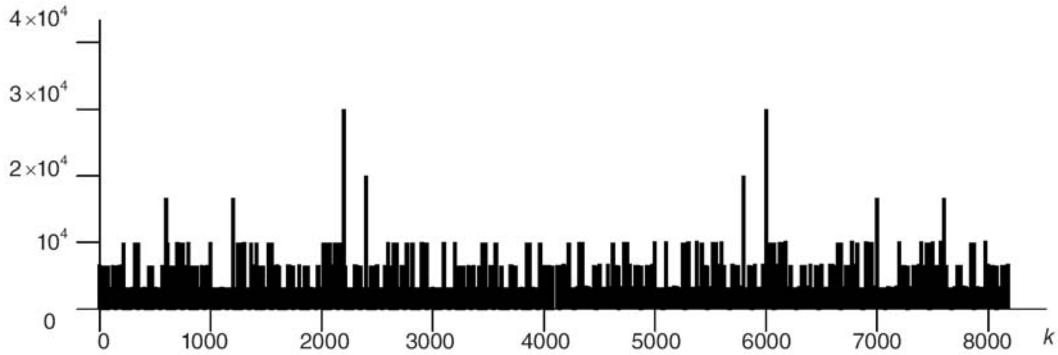


FIGURE 7.56 DFT coefficients.

In Section Answers to selected problems

Page 482

Last two problems should be numbered 7.32 and 7.33 instead of 7.31 and 7.32.

In other words

Replace Heading: Problem 7.31 by 7.32

Replace Heading: Problem 7.32 by 7.33

Chapter 8

Page 504

Example 8.10 first four lines

Should read:

Evaluate and verify the transformation between the canonical

and Jordan state space models of a system of transfer function%

H(s)= ….

Replace We have found

by

Referring to Example 8.4 we may write

Chapter 9

Figure9.32

Caption of Figure9.32 should read

\caption{Magnitude spectrum $|H(j\omega)|$ of ninth order elliptic filter.

Problem 9.23

At the end of this problem add the line:

Verify the solution using Matlab and evaluate and plot the poles and zeros of the resulting filter.

In the section

9.57 Answers to Selected problems

On Page 674

Problem 9.23

After the equation

H_{HPdenorm}(s)= 2.5/…

add the new line

H_{HPdenorm}(s)= (0.891509 s^4)/(4.58063 10^13 + 2.3154 10^10 s + 1.87451 10^7 s^2 + 5078.98 s^3 + s^4).

Chapter 10

Page 682

After Equation (10.51)

Replace

ensures

by

ensure

Page 685

Bottom of page: Example 10.3

Replace

Consider the ladder network of Fig. 10.2.

by

Consider the ladder network of **Fig. 10.3**.

Replace

The filter realization is shown in Fig. 10.25.

by

The filter realization is shown in Fig. 10.25. Alternatively, we may write

Page 725

Paragraph following Eq. (10.250)

Replace

Fig. 10.34 known as

by

Fig. 10.36 known as

Chapter 11

Page 739

Equation (11.23)

Replace, respectively,

c_k and z_k

by

C_k and Z_k

Add Prony's Method (page 790) to index terms.

Page 781 Sec. 11.30

Replace to read

11.30 All-Pass Filter Realization

In a K^{th} order all-zero FIR lattice filter the transfer function between the lower right-most terminal $\tilde{e}_K[n]$ and the upper right-most terminal $y_K[n] = e_K[n]$ is

$$H_{LU}(z) = \frac{E_k(z)}{\tilde{E}_K(z)} = \frac{A_k(z)X(z)}{\tilde{A}_k(z)X(z)} = \frac{A_k(z)}{z^{-K}A_K(z^{-1})}. \qquad (11.275)$$

In a K^{th} order all-pole FIR lattice filter the transfer function between the upper left-most input terminal $x[n] = d_K[n]$ and the lower left-most terminal $\tilde{d}_K[n]$ is

$$H_{UL}(z) = \frac{\tilde{D}_K(z)}{D_k(z)} = \frac{\tilde{A}_k(z)Y_K(z)}{A_k(z)Y_K(z)} = \frac{z^{-K}A_K(z^{-1})}{A_k(z)}. \qquad (11.276)$$

We recall from Equation (6.185) that this is but the general form of an allpass filter.

Page 792

Example 11.21

Replace

cos(gamma_i^n + theta_i)

by

cos(gamma_i n + theta_i)

Section 11.34 Pade Approximation

In the Pad\'{e} approximation approach …

such that the filter impulse response h[n]=… best matches a desired impulse response …

Problems 11.42 to Prob 11.45

Replace h[n-N] by **h[N-n]**

Chapter 12

Problem 12.1

A system has the impulse response%

$$h(t) = \sin \pi t R_T(t) = \ldots$$

Chap 14

Page 919 Sec. 14.9.3

Delete first redundant paragraph.

Second paragraph first line

Replace

Gray code-to-binary

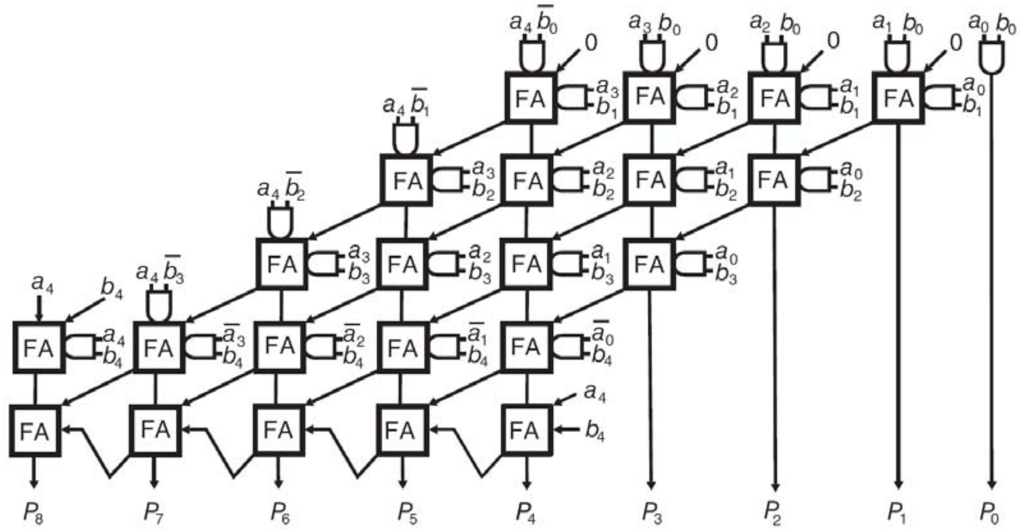
by

binary-to-Gray code

Chap 15

Page 1001

Fig. 15.19 should be as follows:



Page 1006

After Equation (15.105) should read

A combinatorial approach to construct a divider in sign and magnitude and 2's complements is depicted in Fig. 15.20. At each step a subtraction of the divisor is performed. If the remainder does not change sign a success is declared and the quotient bit deduced. If the remainder changed sign a failure is dedlared and restoration is performed using a multiplexer.

Page 1007

Fig. 15.20 Replace as follows

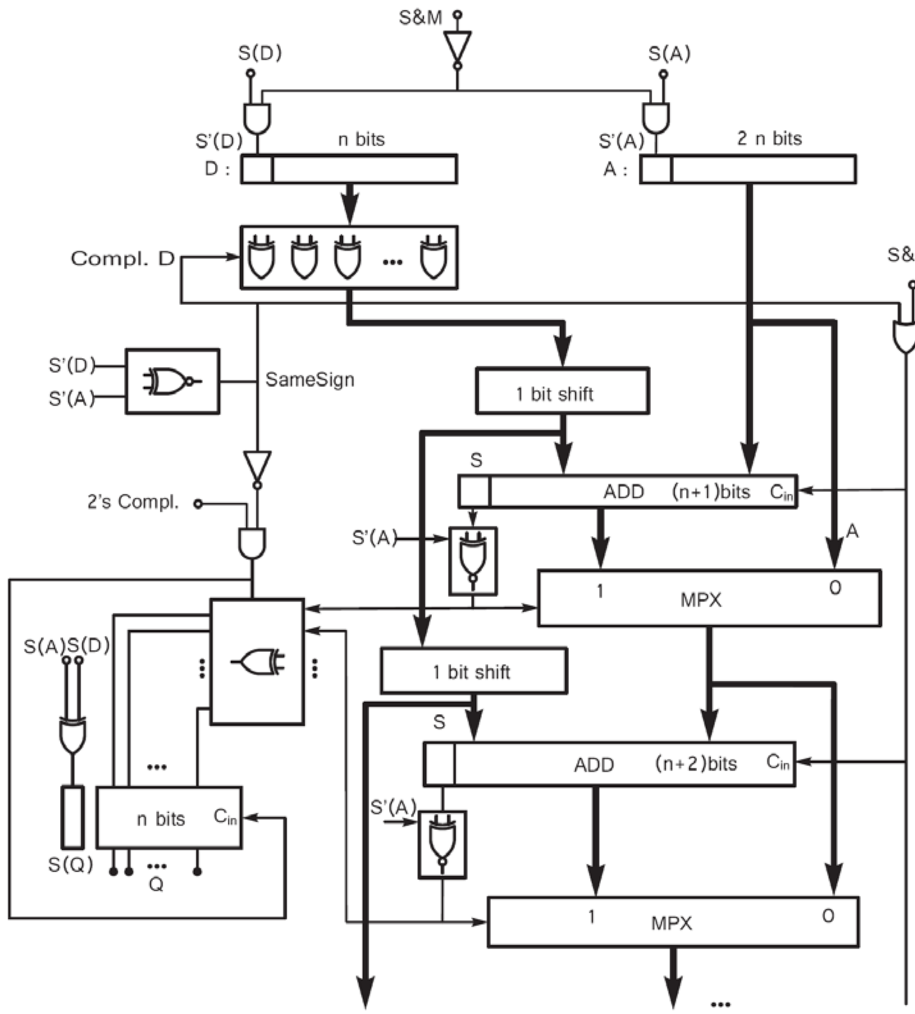


FIGURE 15.20 A combinatorial sign and magnitude and 2's complement divider.

Page 1009
Should read:

15.17 Cellular Array for Nonrestoring Division

A possible cellular array realization for nonrestoring division is shown in Fig. 15.21. Each cell in this figure is the CAS cell shown in Fig. 15.13(b).

The array is a modification of previously proposed structures with the purpose of permitting the division of a $2n-1$-bit dividend with no leading zeros by an n-bit divisor. If the

…

The array depicted in the figure shows the structure of the array divider in this case of $n = 5$, that is, a dividend of 9 magnitude bits and a divisor of 5 magnitude bits.

The successive bits of the dividend $A = 0a_8a_7a_6a_5a_4a_3a_2a_1a_0$ and the divisor $D =$

Page 1010

Fig. 15-21 Correct as shown:

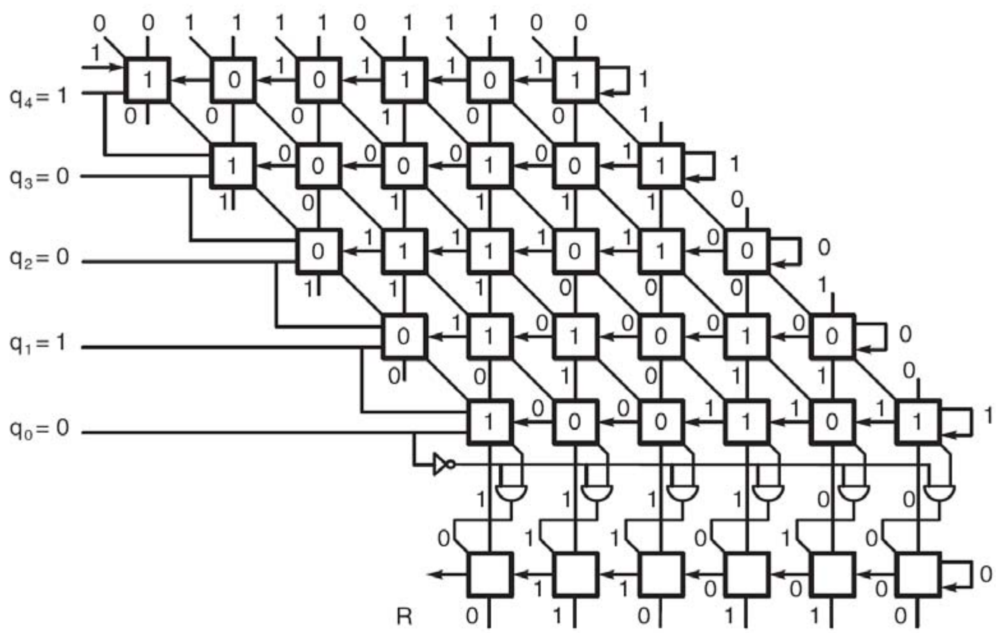


FIGURE 15.21 Cellular array realization for nonrestoring division.

Page 1045

Section 15.29.2 Realization using JK Flip-Flops

The realization using JK$ flip-flops is similarly obtained …. The resulting Karnaugh maps of J_2, J_1, K_2 and K_1 are shown in Fig. 15.47.

Page 1058

From the tables we may define the micro-operations as functions of states and conditions.

We have

\mu_{1} & = (START \leftarrow ON)

…

\mu_{12} & = S_{10},

**\mu_{13} & = & S_{11}UEQ0.\overline{AEQ0}. **

Chap 17

Sec. 17.7 Other Approximating Sequences

Last equation 17.61

Redundant; same as 17.59. Delete it.

Page 1195

After Equation (17.78) should read

obtaining Equation (17.64) as desired. In particular, the expressions for $f(t)\delta''(t)$ and $f(t)\delta^{(3)}(t)$ are

$$f(t)\,\delta''(t) = f''(0)\,\delta(t) - 2f'(0)\,\delta'(t) + f(0)\,\delta''(t) \tag{17.79}$$

$$f(t)\,\delta^{(3)}(t) = -f^{(3)}(0)\,\delta(t) + 3f''(0)\,\delta'(t) - 3f'(0)\,\delta''(t) + f(0)\,\delta^{(3)}(t)\,. \tag{17.80}$$

Page 1200

Section 17.16 now reads

17.16 Some Properties of the Dirac-Delta Impulse

The following is a summary of important properties of the Dirac-delta impulse for future reference.

$$\delta\left[a(t-t_0)\right] = \frac{1}{|a|}\delta\left(t-t_0\right) \tag{17.122}$$

$$\int_{-\infty}^{\infty} \frac{d^n\delta\left(t-t_0\right)}{dt^n}\phi\left(t\right)dt = (-1)^n \frac{d^n}{dt^n}\phi\left(t_0\right) \tag{17.123}$$

$$\frac{d}{dt}u\left(t\right) = \delta\left(t\right) \tag{17.124}$$

$$\int_{-\infty}^{\infty} \delta'\left(t-t_0\right) f\left(t\right)dt = -f'(t_0) \tag{17.125}$$

$$\delta^{(n)}\left(t\right) = (-1)^n n! t^{-n}\delta\left(t\right) \tag{17.126}$$

$$\delta^{(n)}\left(t\right) * f\left(t\right) = f^{(n)}\left(t\right) \tag{17.127}$$

$$\int_{-\infty}^{\infty} t\delta'\left(t\right)dt = -1 \tag{17.128}$$

$$\int \delta^{(n)}\left(t\right) f\left(t\right)dt = (-1)^n f^{(n)}(0) \tag{17.129}$$

$$t^2\delta''\left(t\right) = 2\delta\left(t\right) \tag{17.130}$$

$$t^3\delta''\left(t\right) = 0 \tag{17.131}$$

$$t^n\delta^{(n)}\left(t\right) = (-1)^n n!\delta\left(t\right) \tag{17.132}$$

$$If\ tg_1\left(t\right) = tg_2\left(t\right) \quad then\ \ g_1\left(t\right) = g_2\left(t\right) + c\ \delta\left(t\right), c\ constant. \tag{17.133}$$

$$\int_{-\infty}^{\infty} \delta'\left(t\right)\phi\left(t\right)dt = -\phi'(0) \tag{17.134}$$

$$\int_{-\infty}^{\infty} \delta^{(m)}\left(t\right)dt = 1 \ \text{ iff } m = 0 \tag{17.135}$$

$$\delta'(-t) = -\delta'\left(t\right) \tag{17.136}$$

$$\int_{-\infty}^{\infty} \delta''\left(t\right)dt = 0 \tag{17.137}$$

$$\delta'\left(t\right) * f\left(t\right) = f'\left(t\right) \tag{17.138}$$

$$\delta^{(n)}\left(t\right) * f\left(t\right) = f^{(n)}\left(t\right) \tag{17.139}$$

$$\delta^{(n)}(\omega) * F(j\omega) = F^{(n)}(j\omega) \tag{17.140}$$

$$\int_{-\infty}^{\infty} \delta(t-t_0)\phi\left(t\right)dt = \phi(t_0) \tag{17.141}$$

$$t\delta\left(t\right) = 0 \tag{17.142}$$

$$t\delta'\left(t\right) = -\delta\left(t\right) \tag{17.143}$$

$$t^2\delta'\left(t\right) = 0 \tag{17.144}$$

$$\delta(at) = \frac{1}{|a|}\delta(t) \tag{17.145}$$

$$\delta(\sin t) = \sum_{n=-\infty}^{\infty} \delta(t - n\pi) \tag{17.146}$$

$$\delta(t^2 - a^2) = \frac{1}{2a}\left[\delta(t+a) + \delta(t-a)\right] \tag{17.147}$$

$$f(t)\,\delta'(t) = f(0)\delta'(t) - f'(0)\delta(t) \tag{17.148}$$

$$f(t)\,\delta''(t) = f(0)\delta''(t) - 2f'(0)\delta'(t) + f''(0)\delta(t) \tag{17.149}$$

$$f(t)\,\delta'''(t) = f(0)\delta'''(t) - 3f'(0)\delta''(t) + 3f''(0)\delta'(t) - f'''(0)\delta(t) \tag{17.150}$$

$$f(t)\,\delta^{(n)}(t) = \sum_{k=0}^{n}(-1)^k \frac{n!}{k!\,(n-k)!} f^{(k)}(0)\delta^{(n-k)}(t) \tag{17.151}$$

$$\delta(t-t_1) * \delta(t-t_2) = \delta\left[t - (t_1+t_2)\right] \tag{17.152}$$

$$\delta^{(n)}(-t) = \begin{cases} \delta^{(n)}(t), & n \ \ even \\ -\delta^{(n)}(t), & n \ \ odd \end{cases} \tag{17.153}$$

Page 1202

Sec. 17.19

Should read

17.19 Generalized Limits

We have already seen that a sequence of distributions $g_n(t)$, $n = 1, 2, 3, \ldots$ has as a limit $g(t)$ as $n \longrightarrow \infty$ if

$$\lim_{n\longrightarrow\infty} < g_n,\ \phi > = \lim_{n\longrightarrow\infty} \int_{-\infty}^{\infty} g_n(t)\phi(t)dt = \int_{-\infty}^{\infty} g(t)\phi(t)dt = < g,\ \phi > . \tag{17.169}$$

Page 1221

Problem 17.9 *Evaluate the distribution*

a) $(\sin 2t - 2\cos 3t)\delta(t)$.

Page 1222

Problem 17.9

a) $(\sin 2t - 2\cos 3t)\delta(t) = -2\delta(t)$

Problem 17.10

a) $(d/dt)\,[u(-1-t) - 2u(t-1)] = -\delta(-1-t) - 2\delta(t-1)$

b) $(d/dt)\,[\sin 2t\,\{1 - 2u(t-1)\}] = 2\cos 2t - 2\sin 2\delta(t-1) - 4\cos 2tu(t-1)$

Chap 18

Page 1244

Table 18.5

The transform of $na^n u[n]$ is $\dfrac{az^{-1}}{\left(1-az^{-1}\right)^2} - \pi z\dfrac{d}{dz}\psi(a^{-1}z)$.

The transform of $(n+1)a^n u[n]$ is $\dfrac{1}{\left(1-az^{-1}\right)^2} - \pi\left\{z\dfrac{d}{dz}\psi(a^{-1}z) - \psi(a^{-1}z)\right\}$.

The transform of $n^r u[n]$ is $(-1)^r \sum_{i=1}^{r} S(r,i) \frac{(-1)^i i!}{(z-1)^{i+1}} z^i + (-1)^r \pi \sum_{i=1}^{r} S(r,i) z^i \psi^{(i)}(z)$.

The transform of $n^r u[-n]$ is $\sum_{i=1}^{r} S(r,i) \frac{(-1)^i i!}{(z^{-1}-1)^{i+1}} z^{-i} + \pi \sum_{i=1}^{r} S(r,i) z^{-i} \psi^{(i)}(z^{-1})$.

Last line

The transform of n^r is $(-1)^r 2\pi \sum_{i=1}^{r} S(r,i) z^i \psi^{(i)}(z)$.

Correct table entry at n a^n u[n].

Page 1253

Table 18.12 last entry should read

$n_1^{r_1} n_2^{r_2}$	$(-1)^r 4\pi^2 \left\{ \sum_{i=1}^{r_1} S(r_1, \ i)\, \psi^{(i)}(z_1) \right\} \times \left\{ \sum_{k=1}^{r_2} S(r_2, \ k)\, \psi^{(k)}(z_2) \right\}$

Page 1258

Stirling Numbers First Kind definition:

$$s(n,m) \equiv s_n^m = \sum_{k=0}^{n-m} (-1)^k \binom{n-1+k}{n-m+k} \binom{2n-m}{n-m-k} S(n-m+k,k).$$

(Note that the last S is upper case).

Page 1266 Abu Ja'far … Al-Khwarizmi:

Line 26: Replace wass by was