“Transformers and Inductors for Power Electronics Theory, Design and Applications”

p. xiii: In Hurley bio add He received the IEEE Power Electronics Society Middlebrook Award for technical achievement in 2013 and he was appointed a Distinguished Lecturer of the IEEE for 2014-2015.

Chapter 1

p.4

This law states that the line integral of H around any closed contour is equal to the total current enclosed by that contour, and may be stated in the integral form of (1.1)

Equation (1.9) $\int_0^{2\pi} H(r) r d\theta = i$

Chapter 2

p. 20 Table 1.1: for Amorphous, Pfe is 366, Kc is 1.377, α=1.51 and β=1.74

p. 25 Remove first = sign in equation (2.1)

p. 38 $\mathcal{R}_{eq} = \mathcal{R}_g + 2\mathcal{R}_1 + \frac{\mathcal{R}_2}{2} = [22.1 + (2)(0.42) + (3.38/2)] \times 10^5 = 24.63 \times 10^5$ At/Wb

p. 43 Replace Figure 2.14

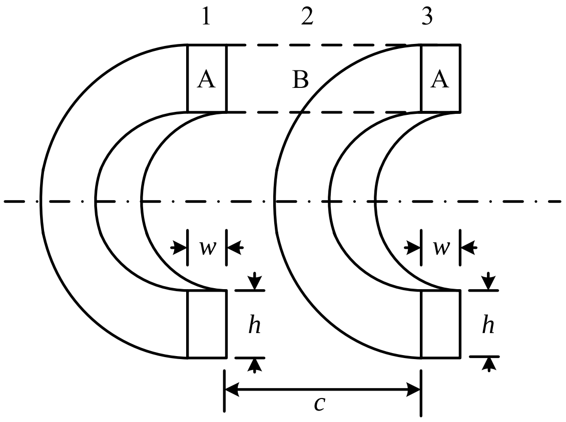
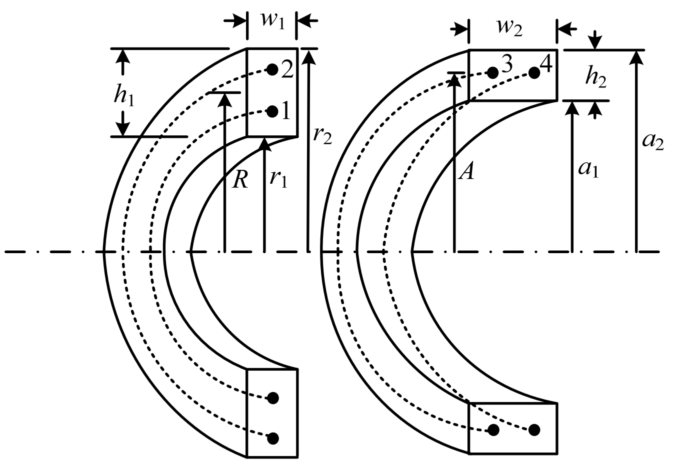


Figure 2.14 GMD between coils of equal area

p. 43 in the last paragraph

We want to calculate the GMD between areas 1 and 3, each having an area $A = h \times w$. Area 2, between Sections 2 and 3, has an area $B = h \times c$.

p.44 Remove solid lines in Figure 2.15



p.44 Rewrite equation (2.58) and (2.59):

$$\ln(R_{13}) = \frac{(2w+c)^2}{2w^2}\ln(R_s) + \frac{c^2}{2w^2}\ln(R_2) - \frac{(w+c)^2}{w^2}\ln(R_{12}) \qquad (2.58)$$

where

$$\begin{aligned} R_1 &= 0.2235(h+w) \\ R_2 &= 0.2235(h+c) \\ R_{12} &= 0.2235(h+w+c) \\ R_s &= 0.2235(h+2w+c) \end{aligned} \qquad (2.59)$$

p.45 15µm instead of 15 mm in three places;
replace z = 0 by z = 55 µm for Coils 1 and 2
replace z = 55 mm by z = 0 for Coils 1 and 4

Coils 1 and 2: $r_1 = a_1 = 1.15$ mm, $r_2 = a_2 = 1.75$ mm, $h_1 = h_2 = 15$ µm
$z = 55$ µm.

Coils 1 and 4: $r_1 = 2.00$ mm, $r_2 = 2.60$ mm, $h_1 = 15$ µm,
$a_1 = 2.00$ mm, $a_2 = 2.60$ mm, $h_2 = 15$ µm,
$z = 0$.

p. 46
$M_{12} = 3.917$ nH

p.51 Problem 2.2: 1.0T should be 1.0 T
p.52 Problem 2.4: insert “The cross-sectional area of the solenoid is 1 cm^2”
p.52 Problem 2.5: insert “Take N=25 turns”

Replace the following section in MATLAB Program for Example 2.5

```
%This section the mutual inductance between sections 1 and 2 is calculated
R2=sqrt(a2_in*a2_out);
GMD_a=0.2235*(w+c12);
GMD_b=0.2235*(w+h1+c12);
GMD_s=0.2235*(w+h1+h2+c12);
GMD_12=(2*h1+c12)^2/(2*(h1^2))*log(GMD_s)+c12^2/(2*(h1^2))*log(GMD_a)-(h1+c12)^2/(h1^2)*log(GMD_b);
GMD_12=exp(GMD_12);
M_12=inductance(R1,R2,GMD_12)
```

Chapter 3

p.68 Replace “An 8 mm x 2 mm wire” with “An 8 mm x 2 mm foil”
p.79 new text to replace second paragraph

The duty cycle is chosen to ensure that the switch stress is minimized, the ratio V_o/V_i should be approximately 0.5 as shown in Figure 3.9 [5] so that for D=0.314 $N_p/N_s = a$ is:

$$a = \frac{V_i}{V_o}\frac{D}{1-D} = \frac{325.3}{24}\frac{0.314}{1-0.314} = 6.2$$

p.81 replace $P_{cu_p\max} = 0.5\,\mathrm{W}$ with $P_{cu_p\max} = (k_{up}/k_u)P_{cu} = (0.0948/0.235)(1.0) = 0.403\,\mathrm{W}$

p.82 $$\mu_{\text{opt}} = \frac{B_{\max} l_c K_{ip}}{\mu_0 \sqrt{\frac{P_{cu_p\max} k_{up} W_a}{\rho_w \text{MLT}}}} = \frac{(0.2)(12.4\times10^{-2})(0.4)}{(4\pi\times10^{-7})\sqrt{\frac{(0.403)(0.155)(2.77\times10^{-4})}{(1.72\times10^{-8})(11.3\times10^{-2})}}} = 83.5$$

$$g_{\max} = \frac{l_c}{\mu_{\min}} = \frac{(12.4\times10^{-2})}{83.5}10^3 = 1.48\,\text{mm}$$

p.84 Remove Problems 3.3 and 3.4 (they already appear in chapter 1)
p.84 Problem 3.7: change 20 kHz to 25 kHz
p.84 Problem 3.8: change 70 kHz to 60 kHz; change 620 µH to 1200 µH; change 30°C to 45°C

Chapter 4

p. 106 Replace φ with ϕ in six places above and below Equations (4.37) and (4.38)
p. 110 K should be K_v in four places in the paragraph above Example 4.1
p.121 Problem 4.5: change triangular to tristate

Chapter 5

p.132 Remove (0.4) from J_o = in the numerator, it appears two times
p.138 V_{rms}/K should read V_{rms}/K_v and V_{dc} should be replaced by V_s in V_{rms} = under **Winding Design**
p.143 $I_{\text{dc}} = I_0$ should read $I_s = I_0$
p.143 change 1.5 V to 1.0 V in "assuming a forward voltage drop of 1.5 V for the diode"
p.144 In A_p = (1.0)(0.4)(48.2…) should read (1.0)(48.2…)
p.151 Problem 5.5: change 25°C to 30°C
p.152 In the MATLAB program Vw-0.28e-2 should read Vw=28e-2

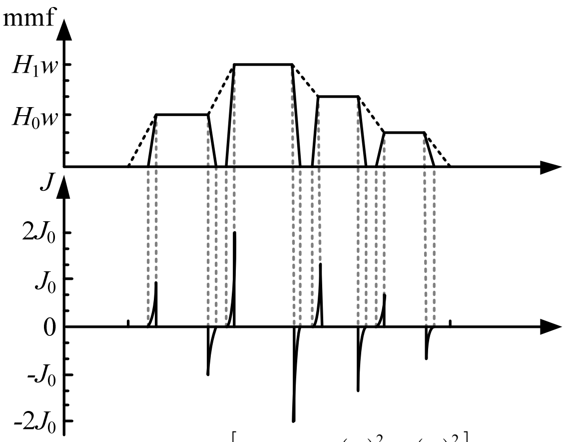
Chapter 6

p. 160 change i_k to i_z in Figure 6.1
p.169 in Equation 6.43: $R_{dc}(NI)^2$ should read $R_{dc}I^2$
p. 173 Replace Equation 6.47 with Equation 6.61
p. 174 Replace Equation 6.47 with Equation 6.61
p.175 Under Figure 6.11 remove the first sentence – "~~The plot in figure 6.9 for the pulsed waveform in Figure 6.8~~".
p. 176 Waveform 6 in the Fourier series, replace D by D/2
p.181 The closest waveform to the input voltage shown in Figure 6.12 is number 5 in Table 6.1 and the optimum layer thickness is

$$\Delta_{\text{opt}} = \sqrt[4]{\frac{\left[D - \frac{4t_r}{3T}\right]2\pi^2\frac{t_r}{T}}{(5p^2-1)/15}} = \sqrt[4]{\frac{\left[0.67 - \frac{(4)(0.025)}{3}\right]2\pi^2(0.025)}{[(5)(6)^2-1]/15}} = 0.4028$$

$$d_{\text{opt}} = \Delta_{\text{opt}}\delta_o = (0.4028)(0.295) = 0.1\,\text{mm}$$

p.183 New version of Figure 6.16



$$\sum J^2 = 2\left[1^2 + 2^2 + \left(\frac{4}{3}\right)^2 + \left(\frac{2}{3}\right)^2\right] = 14.4$$

Visio version available

p.186 in Equation 6.82: add a bracket, coth(Δ(1+j) should read coth(Δ(1+j))

Chapter 7

p.202 change 1.7 to 2.7 in two places
change 0.588 cm to 0.370 cm in two places
change 2.93 MHz to 7.39 MHz

$$R_s = \omega L_0 \frac{\Delta^2}{4} = \pi f^2 \sigma \left(\frac{\mu_r \mu_0 N}{l_c}\right)^2 \frac{A_c l_c \pi b^2}{2} \qquad (7.24)$$

Noting that the volume of the core is simply $A_c l_c$ the instantaneous power loss is $i^2 R_s$ and the instantaneous power loss per unit volume is

$$p = \frac{\pi f^2 \sigma}{2} \left(\frac{\mu_r \mu_0 N i}{l_c}\right)^2 \pi b^2 \qquad (7.25)$$

Applying Ampere's law using (7.7) with the current $Ni = K_f l_c$ means that the term inside the bracket in (7.25) is the magnetic flux density. The length of the winding is taken as the mean core length on the assumption that outside diameter of the toroid is much greater than the diameter of the core cross-section. Assuming the magnetic flux density $B = B_{\max}\sin\omega t$ at the surface of the core the average value of $(B_{\max}\sin\omega t)^2$ is $B_{\max}^2/2$ and the average power loss per unit volume in the core due to eddy currents is:

p.204 In Equation (7.28) the limits 2π to 0 should be 0 to 2π
p.206 In ΔB = replace $2.125\text{x}10^{-4}$ by $1.125\text{x}10^{-4}$
p.206 In P_v = replace 5.56 by 3.964 and 0.198 by 0.32
p.206 In Example 7.5 first line, Example 5.3 should read Example 5.2
p. 226 Remove first = sign in Equation (2.1)

Chapter 8

p.231 Example 8.4: $I_\infty = 0.53$ A should read $I_{oc} = 0.53$ A
$P_1 = 18.5$ W should read $P_{oc} = 18.5$ W
p.244 Problem 8.2:

p.245 Table 8.4: remove columns Z(Ω) and L_{ac}(mH)
p.244 Problem 8.2: add "Take N = 700 turns on a toroidal core with A_c = 5.24 cm^2 and l_c = 33.1 cm"

Chapter 10

p.331 Example 10.9: Equation 10.55 should be Equation 10.52 in two places
p.331 Problem 10.6: Add “and adjusting the power level”
p.335 Add Matlab programs for Example 10.6 and Example 10.7

MATLAB Program for Example 10.7

```
% Example 10.7: Solar Panel with Variable Inductor
% Figure 10.28

% Tidying
close all
clc
clear all

% Constants
Vp = 41.6;            % Input voltage
C = 80e-6;            % Output capacitance
R = 1;                % Inductor resistance
RL = 8;               % Load resistance
fs = 20e3;            % Switching frequency
w = 2*pi*fs;
a = 0.44;             % Duty cycle
deltat = 1e-7;        % Time step
N = 30000;
n = 0;

% Vector sizes
tn = zeros(1,N);
v1 = zeros(1,N);
v2 = zeros(1,N);
v3 = zeros(1,N);
i1 = zeros(1,N);
I2t = zeros(1,N);
I3t = zeros(1,N);
I30t = zeros(1,N);
Lv = zeros(1,N);
Y23 = zeros(1,N);
Y22 = zeros(1,N);
Y32 = zeros(1,N);
Y33 = zeros(1,N);

% Initial conditions
v1(1) = 0;
v2(1) = 0;
v3(1) = 100;
i1(1) = 0;
I2t(1) = 0;
I30t(1) = 0;
I3t(1) = 0;
tn(1) = 0.007;

tn(2) = tn(1)+deltat;
Leff = getVarInd(i1(1));
Y11 = 1/R;
```

```
Y12 = -1/R;
Y13 = 0;
Y21 = -1/R;
Y22(2) = 1/R+deltat/(2*Leff);
Y23(2) = -deltat/(2*Leff);
Y31 = 0;
Y32(2) = -deltat/(2*Leff);
Y33(2) = deltat/(2*Leff)+2*C/deltat;
v1(2) = Vp;
v2(2) = -Y33(2)*Y21/(Y33(2)*Y22(2)-Y23(2)*Y32(2))*v1(2);
v3(2) = 100;
i1(2) = Y11*v1(2)+Y12*v2(2);

% Loop to calculate inductor current
for n = (3:N)
   tn(n) = tn(1)+(n-1)*deltat;
   Leff = getVarInd(i1(n-1));
   Lv(n) = Leff;

   % Terms of Admittance Matrix
   Y22(n) = 1/R+deltat/(2*Leff);
   Y23(n) = -deltat/(2*Leff);
   Y32(n) = -deltat/(2*Leff);
   Y33(n) = deltat/(2*Leff)+2*C/deltat;

   % Current components
   I30t(n-1) = -I30t(n-2)-4*C/deltat*v3(n-1);
   I2t(n-1) = I2t(n-2)+deltat/Leff*(v2(n-1)-v3(n-1));
   I3t(n-1) = I30t(n-1)-I2t(n-1)+v3(n-1)/RL;

   % Voltages
   v1(n) = Vp*square(w*tn(n),a*100);
   if v1(n)<0
      v1(n) = 0;
   end

   v2(n) = -Y33(n)*Y21/(Y33(n)*Y22(n)-Y23(n)*Y32(n))*v1(n)-(Y33(n)*I2t(n-1)-Y23(n)*I3t(n-
1))/(Y33(n)*Y22(n)-Y23(n)*Y32(n));
   v3(n) = -Y32(n)*Y21/(Y32(n)*Y23(n)-Y22(n)*Y33(n))*v1(n)-(Y32(n)*I2t(n-1)-Y22(n)*I3t(n-
1))/(Y32(n)*Y23(n)-Y22(n)*Y33(n));

   % Current
   i1(n) = Y11*v1(n)+Y12*v2(n)+Y13*v3(n);

   if i1(n)<0
      i1(n) = 0;
      v2(n) = v1(n);
      I2t(n-1) = -deltat/(2*Leff)*(v2(n)-v3(n));
      I3t(n-1) = I30t(n-1)-I2t(n-1)+v3(n-1)/RL;
      v3(n) = -Y32(n)*Y21/(Y32(n)*Y23(n)-Y22(n)*Y33(n))*v1(n)-(Y32(n)*I2t(n-1)-Y22(n)*I3t(n-
1))/(Y32(n)*Y23(n)-Y22(n)*Y33(n));
   end
end

figure;
plot(tn,i1)
axis([0.00975 0.010 -5 10]);
title('Inductor current for variable inductance at 200 W/m2')
xlabel('Time (s)')
ylabel('Current (A)')
```

```
% Function to get the value of the variable inductance

function L = getVarInd(z)

if z>4
   z = 4;
end

% Manufacturer's data for MICROMETAL T68-52
i=[0.05:0.05:4];
Lv=[0.2070,0.2057,0.2038,0.2034,0.2027,0.2009,0.1993,0.1980,0.1965,0.1949,0.1931,0.1912,0
.1892,0.1872,0.1851,0.1829,0.1808,0.1786,0.1763,0.1740,0.1716,0.1692,0.1667,0.1643,0.161
9,0.1595,0.1573,0.1551,0.1530,0.1510,0.1490,0.1470,0.1450,0.1431,0.1412,0.1393,0.1374,0.1
356,0.1338,0.1321,0.1303,0.1286,0.1270,0.1253,0.1237,0.1222,0.1206,0.1191,0.1176,0.1161,
0.1147,0.1132,0.1118,0.1104,0.1090,0.1077,0.1063,0.1051,0.1038,0.1026,0.1014,0.1002,0.09
91,0.0980,0.0970,0.0960,0.0950,0.0940,0.0930,0.0920,0.0911,0.0902,0.0892,0.0883,0.0874,0.
0865,0.0857,0.0848,0.0840,0.0832]*1e-3;

k = floor(z/0.05);
if k == 0
   k = 1;
end
L = Lv(k);
```

Appendix A

Add COILCRAFT http://www.coilcraft.com to the list