Introduction to Biomedical Engineering

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Errata

Chapter 1

p. 24, line 38: “Chapter 20” instead of “Chapter 21”

Chapter 3

p. 81, Electricity in the Eighteenth Century

p. 98, Eq. (3.14)

$$E_{Cl} = v_i - v_o = -26 \ln \frac{\left[Cl^-\right]_o}{\left[Cl^-\right]_i} \text{ mV} = 26 \ln \frac{\left[Cl^-\right]_i}{\left[Cl^-\right]_o} \text{ mV}$$

p. 100, Eq. (3.20)

$$P_K = \frac{\mu_K KT}{\delta q} = \frac{D_K}{\delta}$$ (there is no minus sign in front of $\frac{\mu_K KT}{\delta q}$)

p. 101, Eq. (3.24)

$$x\Big|_0^\delta = -\frac{KT\delta}{qV} \ln \left(\frac{J_K}{P_K \delta} + \frac{qV\left[K^+\right]}{KT\delta} \right) \Bigg|_{\left[K^+\right]_i}^{\left[K^+\right]_o}$$

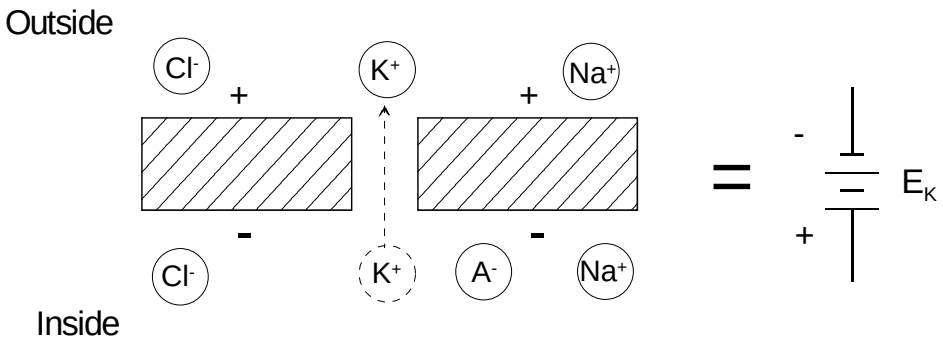
p. 101, Eq. (3.25)

$$\delta = -\frac{KT\delta}{qV} \ln \left(\frac{\frac{J_K}{P_K \delta} + \frac{qV\left[K^+\right]_o}{KT\delta}}{\frac{J_K}{P_K \delta} + \frac{qV\left[K^+\right]_i}{KT\delta}} \right)$$

p. 105

$$J_K = 0 = J_p - \mu_K \left[K^+\right] \frac{dv}{dx} - \frac{KT\mu_K}{q} \frac{d\left[K^+\right]}{dx}$$

p. 106, Figure 3.11
The polarity of the battery is in error in the original figure.



p. 107, Equation at the bottom of the page should be (correction in red)

$$I = \frac{E_K - E_{Na}}{R_{Na} + R_K} = \frac{(-105 - 56)\times 10^{-3}}{(15.67 + 1.7)\times 10^{3}} = -9.27 \quad \mu A$$

p. 108, line after Example Problem 3.5 should read

Find Vm for the frog skeletal muscle if RCl = 3.125 kΩ.

p. 110, Eq. (3.36)

$$V_{Th} = \frac{R_{Na}R_{Cl}E_K + R_K R_{Cl}E_{Na} + R_K R_{Na}E_{Cl}}{R_{Na}R_{Cl} + R_K R_{Cl} + R_K R_{Na}}$$ (REMOVE NEGATIVE SIGN AFTER =)

p. 111, second equation from the bottom of the page, negative sign in front of I_m should be removed.

$$\left(s + \frac{1}{C_m R_{Th}}\right) V_m(s) = V_m(0^+) + \frac{I_m(s)}{C_m} + \frac{V_{Th}}{sC_m R_{Th}}$$

p. 111, last equation on the page, C in the last term should be C_m

$$V_m(s) = \frac{V_m(0^+)}{\left(s + \frac{1}{C_m R_{Th}}\right)} + \frac{K\left(1 - e^{-t_o s}\right)}{sC_m\left(s + \frac{1}{C_m R_{Th}}\right)} + \frac{V_{Th}}{sC_m R_{Th}\left(s + \frac{1}{C_m R_{Th}}\right)}$$

p. 112,

$$I_c = C_m \frac{dV_m}{dt}$$

p. 112, second paragraph from the bottom of the page, line 2: “of 6 ms (upper) and 2 ms (lower)” instead of “of 6 ms (left) and 2 ms (right)”, and lines 4 and 5: “figure on the lower, V_m falls short of the steady state value reached on the upper.” Instead of “figure on the right, V_m falls short of the steady state value reached on the left.”

p. 115, line 16: “from the injection” instead of “from injection”

p. 122, first equation

$$C_m \frac{dV_m}{dt} + \frac{R_l + R_s}{R_l R_s} V_m = \frac{R_l V_c + R_s E_l}{R_l R_s}$$

p. 124, Eq. (3.43) – Equations for β_n and V missing

$$\beta_n = 0.125 e^{\frac{V}{80}}$$

$$V = V_{rp} - V_m$$

p. 124, Eq. (3.45), α_m equation should have the multiplier 0.1 instead of 0.01

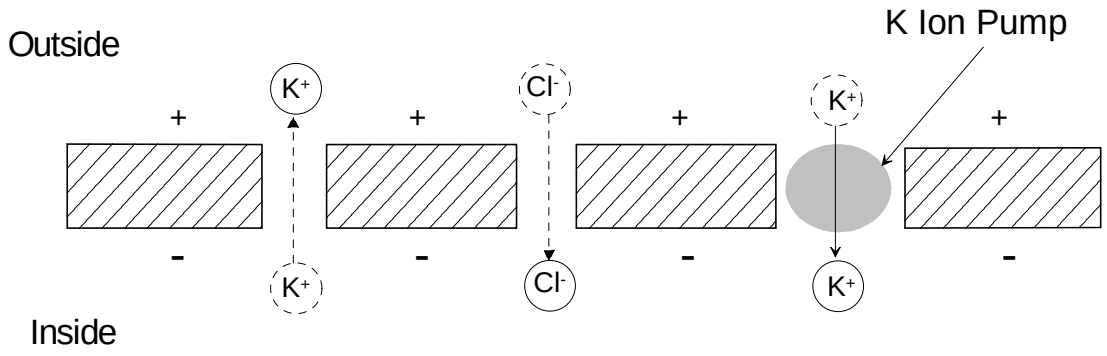
$$\alpha_m = 0.1 \frac{V + 25}{e^{\frac{V+25}{10}} - 1}$$

p. 125, “The units for the αis and βis in Equations 11.43, 11.45 and 11.46 are ms^{-1} while n, m and h are dimensionless and range in value from 0 to 1.”

p. 127, second line. $G_K = 0.3667 \times 10^{-3}\ S$ and $G_{Na} = 0.010614 \times 10^{-3}\ S$. The $\times 10^{-3}\ S$ is missing.

p. 132, Problem 10. The inside and outside concentrations are reversed.

p. 133, Figure for Exercise 13 missing the “K Ion Pump” label.



Chapter 4

p. 152, Example Problem 4.5, first line: "…..with a stretching resistance….." should read: "…..with a resting resistance….."

p. 176, Exercise 3: “Determine the ratio between the cross-sectional areas of two blood vessels. Assume that the voltage ratio induced in identical magnetic flow probes is equal to 1:5 and the ratio of blood flow through these vessels is 2:3.” instead of “Determine the ration between the cross-sectional areas of two blood vessels. Assume that the voltage ration induced in identical magnetic flow probes is equal to 1:5 and the ratio of blood flow through these vessels is 2:3.”

Chapter 5

p. 184, line 17: “are intended to be observed” instead of “are intended to the observed”

p. 189, above Eq. (5.10): “impedances” instead of “impedance”

p. 216, Eq. (5.49)

$$\frac{V_{in}(s)-V_A(s)}{\frac{1}{sC_1}}+\frac{V_{out}(s)-V_A(s)}{R_2}=\frac{V_A(s)-V_{out}(s)}{\frac{1}{sC_2}}$$

Chapter 6

p. 244, Figure 6.6 caption: “36-Hz” at the end of the 2nd sentence should be “360-Hz”.

Chapter 7

p. 300, last line (change 11.8 to 11)

the eyeball radius of 11 mm.

p. 306, Equation 7.15 and the next few sentences

$$T=\frac{K_{se}}{K_{se}+K_{lt}}\left(F+K_{se}x_1\right)-K_{se}x_1=\frac{K_{se}}{K_{se}+K_{lt}}F-\frac{K_{se}K_{lt}}{K_{se}+K_{lt}}x_1 \qquad (7.15)$$

Equation 7.15 is an equation for a straight line with y-intercept $\frac{K_{se}}{K_{se}+K_{lt}}F$ and slope $\frac{K_{se}K_{lt}}{K_{se}+K_{lt}}$. The slope of the length-tension curve in Figure 7.11 is given by K = 0.8 g/° = 40.86 N/m. Therefore,

$$K=\frac{K_{se}K_{lt}}{K_{se}+K_{lt}}=40.86\ \ \frac{N}{m} \qquad (7.16)$$

p. 309, Second line from the bottom of the page, “the lever is considered in Section 7.6.2.”

p. 311, Equation 7.21 should be

$$T = F - B\dot{x}_2$$

p. 315, Equation 7.28

$F = 0.4 + 0.012\theta\ N$ for $\theta \leq 0°$ (T direction)

Aside: This equation corrects the negative sign associated with θ, and making the slope at 0.012 rather than 0.125, giving a slightly better fit to the data. The point at -45° is still not fit altogether well. this isn’t really a problem since a saccade of -45° does not occur naturally. The revised equation should be

$F = 0.4 + 0.012\theta\ N$ for $\theta \leq 0°$ (T direction)

p. 315, fourth line

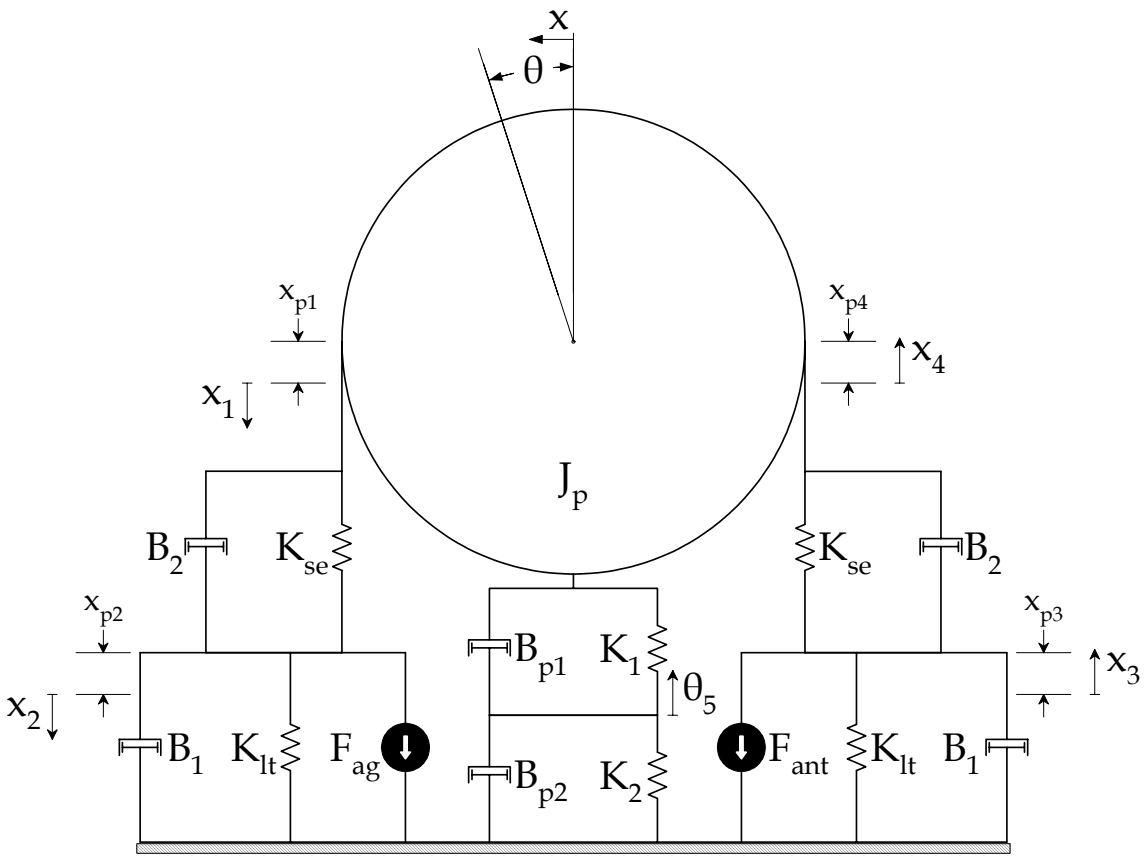
$\theta = 5208.7 \times (x_1 - 3.705)$ (remove the mm from the equation)

p. 326, θ should be replaced by x in Equation 7.40

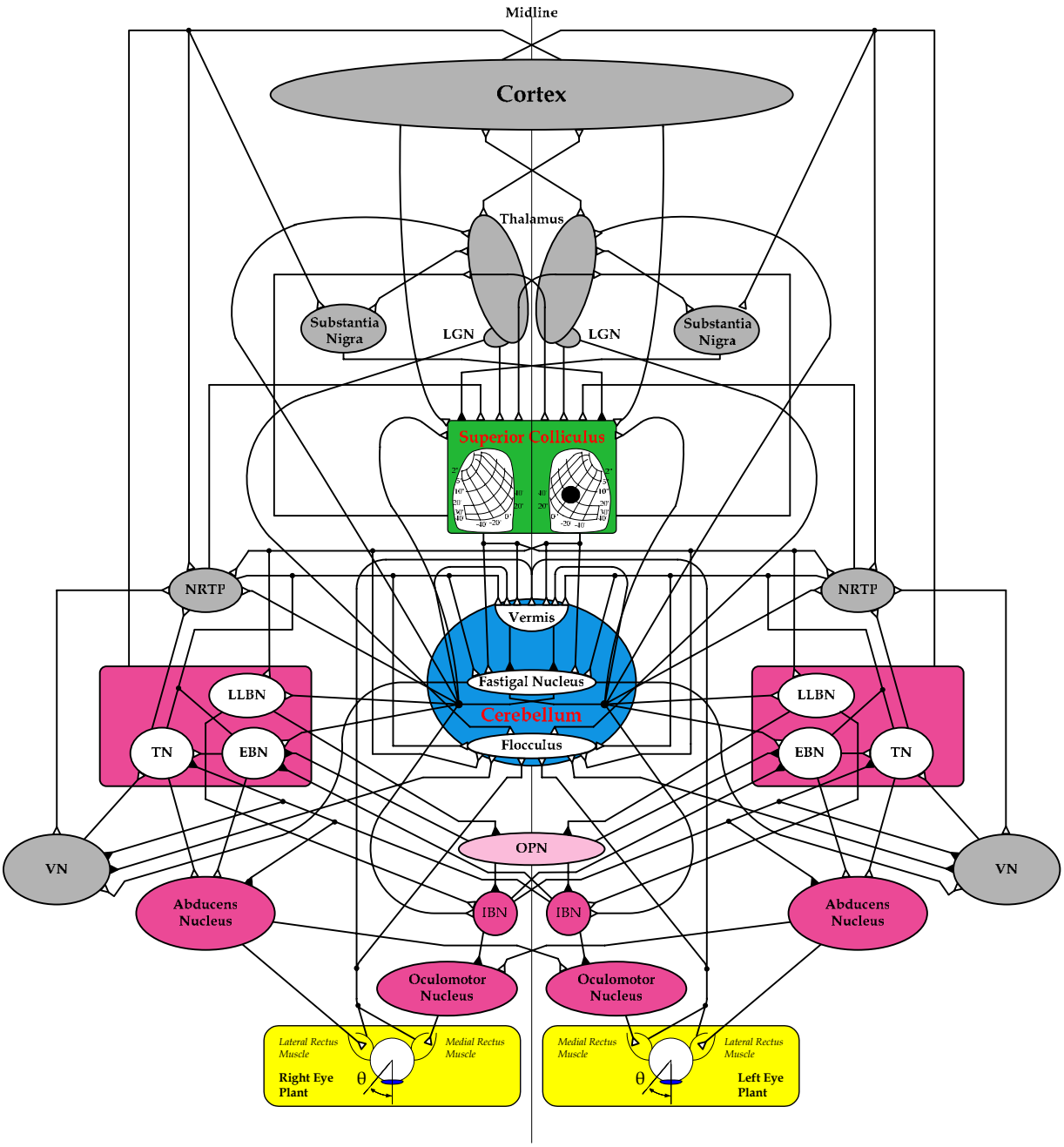
$$K_{SE}K_{12}\left(F_{AG} - F_{ANT}\right) + \left(K_{SE}B_{34} + B_2K_{12}\right)\left(\dot{F}_{AG} - \dot{F}_{ANT}\right) + B_2B_{34}\left(\ddot{F}_{AG} - \ddot{F}_{ANT}\right) = C_4\,\ddot{\ddot{x}} + C_3\,\dddot{x} + C_2\,\ddot{x} + C_1\,\dot{x} + C_0x$$

Expression for $\delta = \dfrac{57.296}{rC_4}$

p. 325, Figure 7.27 q5 should be $\theta 5$.



p. 334, Figure 7.28 has two arrows in the wrong direction for the EBN.



p. 345, Equation 7.47

$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)}$$

Chapter 8

p. 394, below equation 8.58, the term in the square root a should be squared, not subscripted

$$\alpha = 0.5\left[a + \sqrt{a^2 - b}\right]$$

p. 395, 10th line of center text block, the word estimated was misspelled as “estiamted”

p. 396, 10th line of section 8.4, the word estimation is misspelled as “estiamtion”

p. 403, Top of the page, incorrect numbering of subchapter

Chapter 9

p. 438, in middle of page,

$\sum F_x : A_x = 0$ should be $\sum F_x : A_x = F_x = 376N$

p. 458, the text should be changed as follows

[A] = [efa] [A’] (9.58)

Consequently a vector **[A]** expressed relative to lab coordinates may be transformed into foot coordinates by transposing the matrix **[efa]**,

[A’] = [efa]T [A] (9.59)

These vector operations are easily performed using MATLAB:

r1 = -0.032 **i** + 0.002 **j** + 0.003 **k**

= -0.032 **i'** - 0.004 **k'** m

p. 459 (section 3), on the right-hand side of these expressions,

change “0.0” to “-1.4 x 10-5”

change “0.0028” to “2.8 x 10-3”

change “-0.0021” to “-2.1 x 10-3”

p. 459 (section 4), should be changed as follows

All values are then substituted into back Euler's equations, Eqns. (9.44) – (9.46), to yield $\mathbf{M_A}$ in terms of foot (primed) coordinates

$\mathbf{M_A}$ = [I] $\boldsymbol{\alpha_{foot}}$ + $\boldsymbol{\omega_{foot}}$ x [I] $\boldsymbol{\omega_{foot}}$ − $\mathbf{r_1}$ x $\mathbf{F_A}$ − $\mathbf{r_2}$ x $\mathbf{F_g}$ − $\mathbf{T_g}$

= 1.50 **i'** + 15.9 **j'** - 1.16 **k'**

that is, in turn, transformed back into lab (unprimed) coordinates, i.e. Eqn. (9.59):

$\mathbf{M_A}$ = 2.54 **i** + 15.9 **j** - 0.037 **k** N m

By combining the ankle moment with the ankle angular velocity, the instantaneous ankle power may be computed as

$\mathbf{M_A} \cdot \boldsymbol{\omega_{ankle}}$ = (2.54 **i** + 15.9 **j** - 0.037 **k** N m) • (-0.000759 **i** + 1.47 **j** + 0.0106 **k** rad/s)

= 23.3 Watts

or

$\mathbf{M_{A'}} \bullet \boldsymbol{\omega}_{\mathbf{ankle'}}$ = (1.50 **i'** + 15.9 **j'** - 1.16 **k'** N m) • (-0.0946 **i'** + 1.46 **j'** + -0.140 **k'** rad/s)

= 23.3 Watts

which is thought to be a quantitative measure of the contribution by the ankle to propulsion.

Chapter 10

p. 481, immediately preceding Equation (10.7b), the sentence should read (with clarification in caps): "For example, the coefficient C_1 for human blood DOES NOT HAVE THE CONSTANT VALUE LISTED IN TABLE 10.3, BUT, RATHER, depends on plasma globulin concentration..."

p. 481, following equation (10.7b), the dimensions of C_1 should be d Pa(s)^n (not $^{n-1}$).

p. 493, while some would prefer to move this graph about 60 msec to the left, note that the speed of propagation properties of the depolarization potential has not really been measured in a definitive way relative to the resulting ECG signal..

p. 507, in Example Problem 10.9, the denominator in the equation for q should be: 10.344 $(Kl)^{1/n}$.(the superscript (1/n) is missing; Also, in the next sentence, the denominator should not be K, but, rather, $K(Kl)^{0.275}$. An entire term was left out of this expression.

p. 531, similarly, in Exercise 6, the dimensions of C_1 should, again, be d Pa(s)^n (not $^{n-1}$).

Chapter 18

p. 926, Figure 18.8, the lowest weight should be 40 lb, not 4 lb.

Chapter 19

p. 961, 1st Equation on the page

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$