FIGURE B.1

A simple, single-loop, linear negative feedback (NFB) system block diagram. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

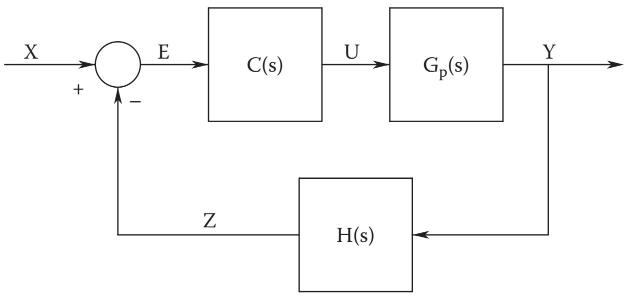

FIGURE B.2

Vectors in the **s**-plane showing parameters required to calculate the RL branch break-away point, −P, on the negative real axis. An NFB system loop gain with three, negative real poles is shown. See text for description. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

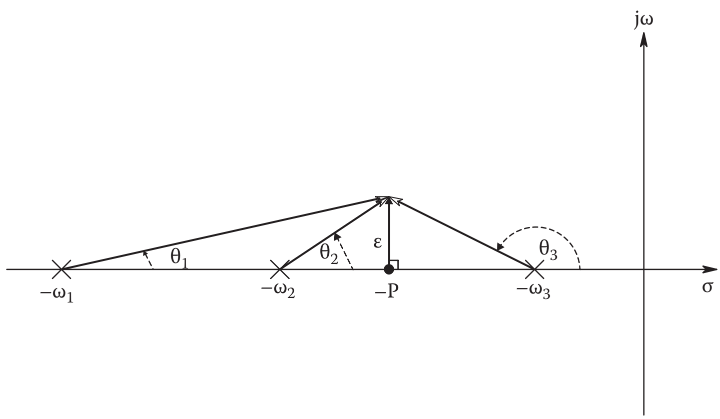

FIGURE B.3

A RL plot done with MATLAB for an NFB system with real poles at $\mathbf{s}=0$ and $\mathbf{s}=-3$, and CC poles at $\mathbf{s}=-1\pm j2$. There are no finite zeros. The asymptote angles are ±45° and ±135°. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

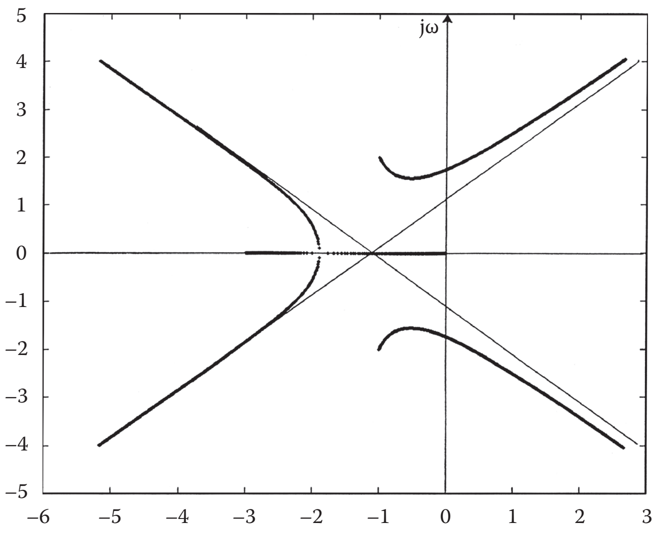

FIGURE B.4

(A) Illustration of the circle RL. The NFB system's loop gain has real poles at − c and −b, and a zero at −a. (B) The interrupted circle RL. The poles are at $\mathbf{s} = -\alpha \pm j\gamma$, and the real zero is at $-\sigma$. See text for details. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

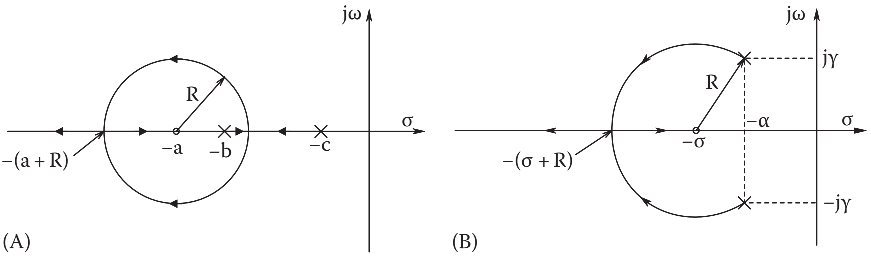

FIGURE B.5

RL diagram of a simple NFB system with a loop gain real-pole at $\mathbf{s} = -1$, a scalar gain K, and a transport lag, e^{-s}. See text for discussion. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

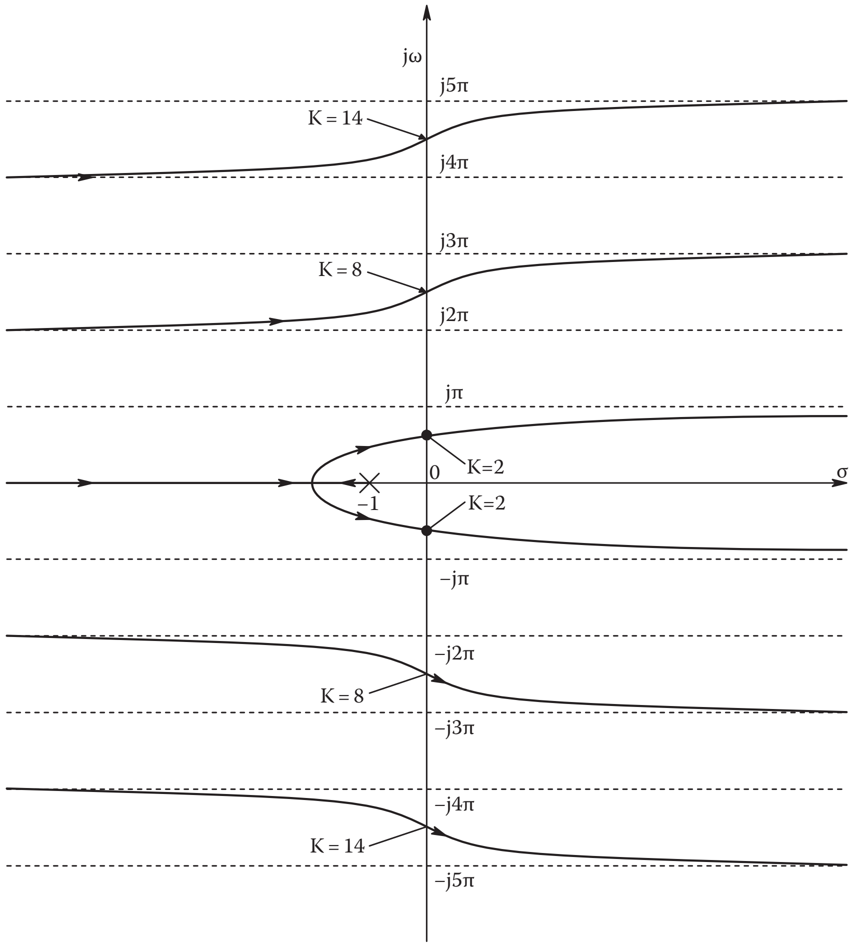

FIGURE B.6

RL diagram for an NFB system with a loop gain with a pole at $\mathbf{s} = -1$ and $\mathbf{s} = -5$. The break-away point on the real axis is at $\mathbf{s} = -3$. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

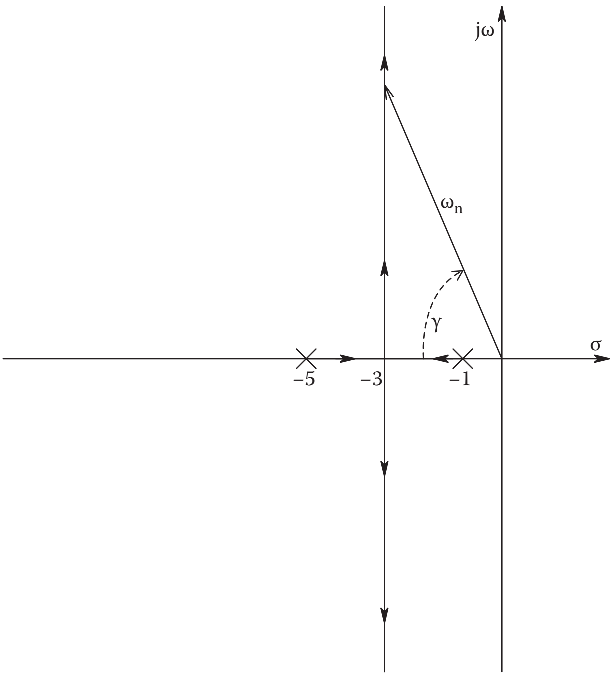

FIGURE B.7

RL diagram of the loop gain given by Equation B.23. The system is given PD compensation. Because the closed-loop system poles' damping $\xi = 0.707$ line intersects the circle RL at two points, we choose the higher gain (K_pK_c) that causes the system to have the higher natural frequency, hence step response speed. See text for calculations. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

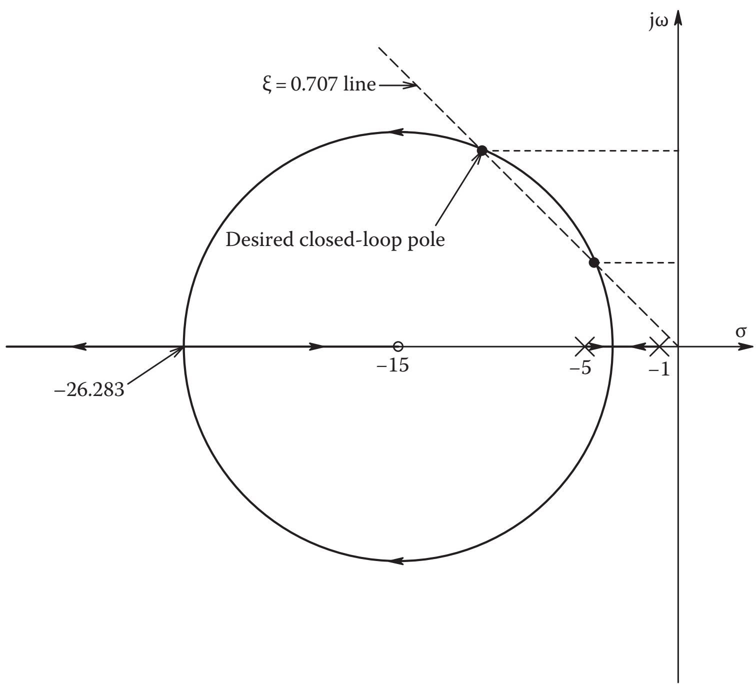

FIGURE B.8

Unit step response of the PD-compensated system of Example 4 (Figure B.7). Vertical axis: closed-loop system output. Horizontal axis: time in seconds. All traces: $K_p = 5$. Trace $1 = K_c = 1$, trace $2 = K_c = 3.15$, trace $3 = K_c = 10$, trace $4 = K_c = 50$. At $K_c = 3.15$, the closed loop $\xi = 0.707$. Note there is no overshoot for $K_c \geq 10$. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)

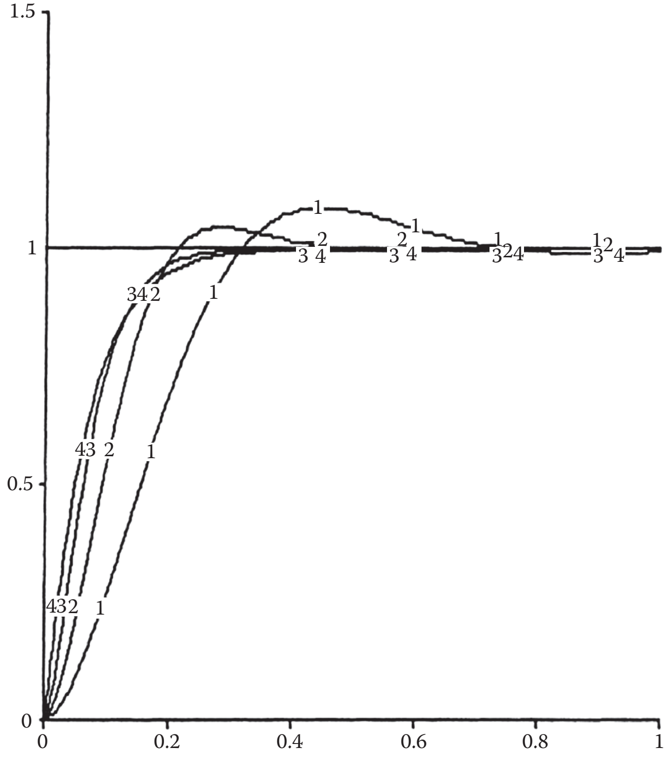

FIGURE B.9

MATLAB RL plot of the system with loop gain given by Equation B.23. K_pK_c ranges from 0 to 50 in increments of 0.10. (From Northrop, R.B., *Endogenous and Exogenous Regulation and Control of Physiological Systems*, Chapman & Hall/CRC Press, Boca Raton, FL, 2000.)