<u>Answers to Problems</u> (4/3/08 update)

1.1 (b) -3E-4, 10 kHz; (c) 1.94 rad, 204 Hz; (d) 0.6 c, 2;
(e) 0.5, 40 MHz/V (f) 1.25 c, 1.5

1.2 16 MHz to 18 MHz, no

1.3 16.682 MHz to 17.318 MHz

2.1 5 kHz, -90°

2.2 (b) 3 MHz

2.3 (b) 4.6 msec., (d) 460 μsec., (e) 0.1 rad.

3.1 3 V/c = 0.48 V/rad

3.2 (a) 3 mA/c = 4.77E-4 A/rad; (b) 667 Ω; (c) +V and -V increase by 2 V.

3.3 (a) 0.0909(10^4 rad/sec + s)/(909 rad/sec + s); (b) 0.29∠-56.4°

3.4 (a) 5 kΩ; 1.59 μF; (b) 1 MΩ; (c) R_{2s} = 20 kΩ; R_{2p} = 80 kΩ; $C = 9.95\times10^{-8}$ F

3.5 (a) Fig. 3.23*e*; 1 kΩ, 1×10^{-8}F; (b) Fig. 3.23*e* from PD out to ground; 1000 pF;
(c) 0.126 mA

4.1 (a) ω_n = 100 rad/sec, ζ= 0.3; (b) ω_n = 100 rad/sec; ζ= 0.05;
(c) ω_n = 31.6 rad/sec, ζ= 0.079; (d) ω_n = 100 rad/sec; ζ= 0.25

4.2 (a) [1 + j0.002 sec/rad ω_m]/[1 - (ω_m sec/rad/477)^2 + j0.0022 sec/rad ω_m];
(b) 0.0132 rad; (c) 0.000145 rad; (d) 13.2 Hz

5.1 (b) PM is 37.9°, 37.1° for the tangential approximation. Gain margin is infinite.

5.2 Approximation: 18.7 dB at 7000 Hz and 52.7° at 1260 Hz. Accurate values:
23.5 dB at 6980 Hz and 54.2° at 1172 Hz.

5.3 10,039 Ω; 3578 sec^{-1}, ≈ 3795 sec^{-1}

5.4 20 dB approximate, 20.086 dB accurate.

6.1 (a) 5 μF; (b) φ_e = 1 rad.

6.2 (a) 984 kHz; (b) 1002 kHz; (c) 3 V/cycle; (d) 1; (e) 6 kHz/V;
(f) 7.14×10^4 rad/sec; (g) 3.59×10^4 rad/sec; (h) ≈ 1; (i) 1.748×10^4 rad/sec;
(j) 0.889 cycle = 5.59 rad; (k) 112 μsec.

6.3 10 kΩ.

6.4 0.153 rad

6.5 11.3 rad at 4 msec

6.6 0.063 rad

7.1 (a) 10 MHz; (b) 1 kHz; (c) 200 rad/sec = 31.8 Hz; (d) 31.4 rad;
(e) 3.93 msec; (f) 11.78 msec.

7.2 (a) 0.01 V; (b) 5.79 kHz/V, $\approx$ 5 kHz/V; (c) 10 Hz; (d) 10^{-3} V

7.3 (a) 0.3; (b) 1.41 kHz

7.4 (a) 10 V/rad; (b) 0, $1/\sqrt{2}$; (c) 6.28×10^4 rad/sec

7.5 0.4 rad at 7070 Hz

7.6 (a) 10 μF; (b) 14 dB; (c) 0.2 rad

8.1 (a) 30.64 MHz, 1.925×10^8 rad/sec;
(b) 30.063 MHz, $K/\omega_z = \omega_z/\omega_p = 200 >> 1$;
(c) 3170 Hz, $\omega_z/\omega_L = 1 \not\ll 1$;
(d) 972 μsec, $\Omega_{PI}/\Omega = 4.5$, $\Omega/\Omega_S = 4.4$, 900 μsec;
(e) 179 μsec, $\Omega_{PI}/\Omega = 10.6$, $\Omega/\Omega_S = 1.9$, 100 μsec

8.2 (a) 5.07×10^6 rad/sec = 807 kHz; (b) 8×10^6 rad/sec = 1.27 MHz

8.3 True K: (a) 4.78×10^6 sec^{-1}; (b) 3.38×10^6 sec^{-1}. Design values (not accounting for IF-filter loss) are 3 dB higher.

8.4 (a) 0.1 rad; (b) 200 Hz

9.1 (a) 1.25×10^5 rad/sec^2; (b) -30°; (c) 0.173 V; (d) 0.2 V

9.2 698 sec^{-1}

9.3 1207 Hz

9.4 4.87×10^7 rad/sec^2

9.5 (a) 7 MHz ± 800 Hz; (b) 7 MHz ± 35.8 kHz; (c) 69 msec;
(d) 7.8 MHz; (e) 0.62 sec

11.1 (a) 5×10^{-7}, 1.6×10^{-5}; (b) 2.5×10^{-13}, 2.53×10^{-10}; (c) 5.37×10^{-3}, 1.84×10^{-3};
(d) 2.89×10^{-4}, 3.39×10^{-5}; (e) 1.6×10^{-6}, 4.93×10^{-7}

11.2 0.044 rad^2

11.4 (a) 6.9×10^{-5} rad^2/Hz; (b) 0.71 or -1.5 dB

12.1 Some points: $S_{\varphi A}$: -70 dBc/Hz at 10Hz, 1 kHz, 10 kHz;
-82 dBr/Hz at 200 kHz. S_B: -20 dBr/Hz at 100 Hz; -94 dBr/Hz at 40 kHz;
-114 dBr/Hz at 200 kHz.

12.2 (a) 0.495 rad^2; (b) 0.00975 rad^2; (c) 0.00101 rad^2; (d) 0.506 rad^2

12.3 8.85×10^{-13} V^2/Hz

12.4 10 kHz

12.5 4.3×10^{-7} rad^2/Hz

13.1 (b) -90; (c) -93; (d) -90; (e) -93

13.2 (a) 0 at DC, rising to 1.33×10^{-11} V^2/Hz peak at 280 kHz,
toward 10^{-11} V^2/Hz at high frequencies, falling at 400 kHz;
(b) 10^{-9} rad^2/Hz at DC, falling to 2.5×10^{-10} rad^2/Hz by 200 kHz,
then to zero at 400 kHz;
(c) -93 dBc/Hz at 3 MHz, falling to -99 dBc/Hz at ±200 kHz,
dropping to zero at ±400 kHz.

13.3 (a) 1.507 V vs. (π/2) V; (b) 0.7738 V; (c) 1 V, 0.6065 V

14.1 (a) 250 Hz; (b) 7250 Hz; (c) 2500 Hz; (d) 31.25 Hz

14.2 1968 Hz

14.3 (a) type-two second-order (integrator and lead), $\zeta = 1/\sqrt{2}$;
(b) 1.12×10^{5} rad/sec, 0.059 rad^2

15.1 (a) 0.01 V; (b) $\pi\times10^{6}$ rad/sec; (c) Section 7.6.4; (d) $\lesssim 1.4\times10^{-6}$ V^2;
(e) 0.14 rad; (f) 5×10^{5} Hz; (g) -13 dBm; (h) 5×10^{5} Hz

16.1 (a) 52.28°; (b) 4.95 kHz; (c) 41.9°; (d) 3876 Hz; (e) no change;

(f) 0.5 $\Rightarrow$ -3 dB; (g) 0.457 $\Rightarrow$ -3.4 dB

16.2 (a) 3.72 dB approximate, 3.94 dB accurate; (b) 3 dB; (c) infinite

16.3 800 $\times 10^{-6}$ rad^2

17.1 (a) 0.29; (b) 8890 rad/sec

17.2 1166 Hz using one term for I_0, 1032 Hz using two; 975 Hz exactly

17.3 (a) 11.81 rad/sec (11.58 rad/sec using two terms for I_0; 10.52 rad/sec using one term); (b) 0.39; (c) 0.67 rad^2

18.1 (a) 0.284 rad^2; (b) 0.314 rad^2; (c) 16.43°

18.2 (a) 18.4°; (b) 13.3°

18.3 (a) 2.5×10^{-4} rad^2; (b) 4.27×10^{-4} rad^2; (c) 3.65×10^{-4} rad^2; (d) 3.2×10^{-4} rad^2

18.4 (a) 1.6 $\Rightarrow$ 2 dB; (b) 4.7 dB; (c) 0.8; (d) 37°; (e) 0.45 rad^2

18.5 (a) $\omega_n = 10^4$ rad/sec, $\zeta = 2$, $\alpha = 0.98$, $B_n = 10229$ Hz;
(b) $\omega_n = 8.82\times 10^3$ rad/sec, $\zeta = 1.78$, $\alpha = 0.974$, $B_n = 8062$ Hz;
(c) 0.385 rad^2; (d) 0.35 rad^2

19.1 (a) 0.37; (b) increase, Fig. 19.6; (c) 0.7; (d) 0.57; (e) 0.44; (f) 0.36; (g) 72.2 $\Rightarrow$ 18.6 dB; (h) 0.64 rad^2

20.1 (a) 41.3 Hz; (b) 4.2 Hz; (c) 40 Hz

20.2 (a) 0.44 rad^2; (b) 0.13 rad^2; (c) 0.4 dB degradation

20.3 1.1 dB

20.4 22.9 dB