Assignment for Chapter 6:

Frequency Domain Analysis

6-1 Using the straight-line approximations, plot the Bode Diagram (Log-magnitude diagram and Log-phase diagram) of the systems described by the following open-loop transfer functions. Determine the Gain crossover frequency ω_c and Phase crossover frequency ω_g.

(1) $G(s)=\dfrac{20}{s(s+10)(s+20)}$

(2) $G(s)=\dfrac{5}{s(0.01s^2+0.1s+1)}$

(3) $G(s)=\dfrac{40}{s(s-10)(s+20)}$

6-2 Please sketch the Nyquist Diagram of the systems described by the following open-loop transfer functions.

(1) $G(s)=\dfrac{100}{s(s+10)(s+20)}$

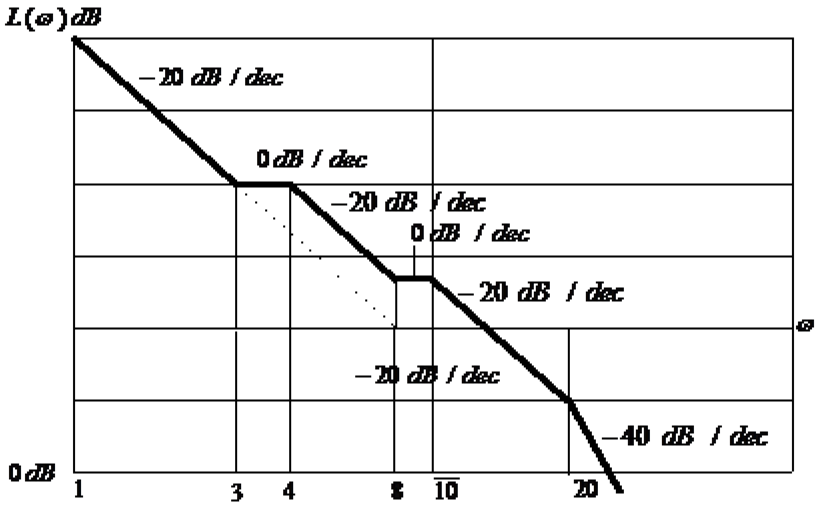
(2) $G(s)=\dfrac{10}{s^3(s+1)(s+2)}$

(3) $G(s)=\dfrac{10(s-1)}{s(s+2)}$

6-3 Consider the unity-feedback control system described by the open-loop transfer function

$$G(s)=\frac{K(s+8)(as+1)}{s(0.1s+1)(0.25s+1)(bs+1)}.$$

Its Bode diagram is shown in the following figure. Determine the values of K, a and b.



6-4 By using Bode Diagram based stability analysis, please judge if the systems (1)-(3) in 6-1 are stable. If they are stable, please determine the phase margin γ and gain margin GM .

6-5 Please use Nyquist criterion to judge if the systems in 6-2 are stable. Please determine Phase Margin γ and Gain Margin GM .

6-6 Consider the unity-feedback control system described by the open-loop transfer function

$$G(s)=\frac{K_r}{s(s+10)}.$$

If the overshot of the closed-loop system satisfies $M_p \leq 5\%$, please determine

(1) open-loop gain (Evan's gain);

(2) resonant peak $M_{p\omega}$ of the closed-loop system;

(3) resonant frequency ω_r of the closed-loop system;

(4) band-width ω_b;

(5) unit step response of the closed-loop system.

6-7 Sketch the Nyquist diagram of the systems described by the following open-loop transfer functions. From the obtained Nyquist diagrams, find the range of K for which the systems are stable.

(1) $G(s)=\dfrac{K}{s(s^2+2s+4)}$

(2) $G(s)=\dfrac{K(s+1)(s-2)}{s^2(s+4)(-s+1)}$

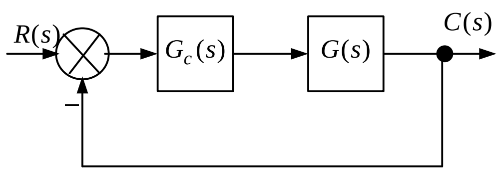
6-8 A control system is shown in the block diagram (a), and $G(s)$ and $G_c(s)$ are both of minimum phase. The Log-magnitude diagrams of $G(s)$ and $G_c(s)G(s)$ are given in Figure (b). Please determine

(1) the transfer function of $G_c(s)$;

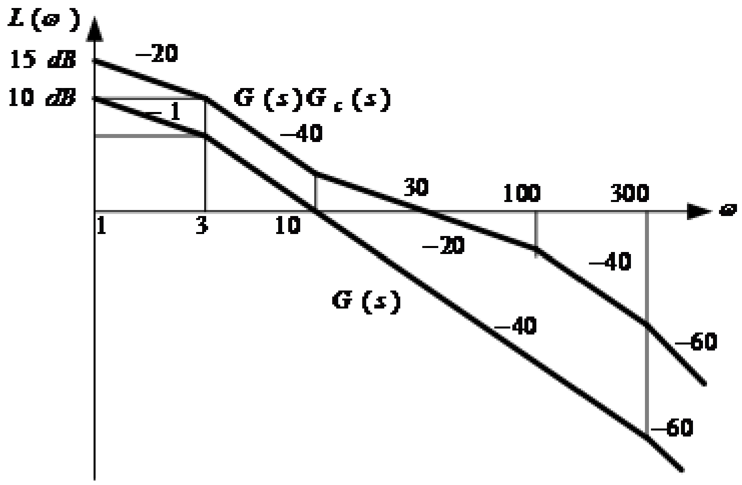
(2) steady-state error constants K_p, K_v and K_a of $G(s)$ and $G_c(s)G(s)$, respectively;

(3) phase margin of $G(s)$ and $G_c(s)G(s)$;

(4) the system overshoots with and without $G_c(s)$, respectively.



(a)



(b)