EE 231 | Exam#3 | Dec. 05, 1989

75 minutes

1. Consider a unity feedback control system with the open-loop transfer function

$$G(s) = \frac{K}{(s-1)(s+3)(s+5)}$$

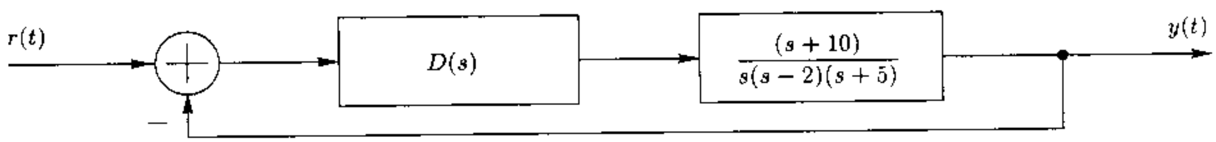
   (a) Construct the root locus diagram. Indicate important features like asymptotes, imaginary axis crossings and break-away points. (22pts)

   (b) Determine the values of K such that the closed-loop system is stable. (03pts)

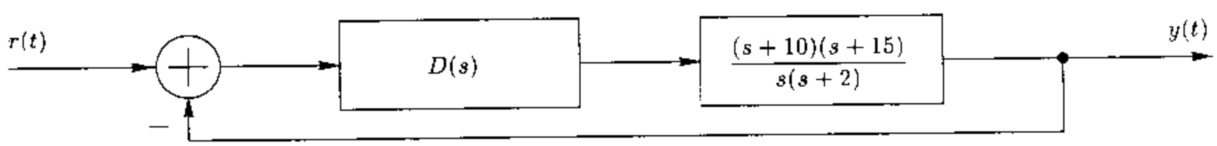
   (c) Determine the value(s) of K such that the system has sustained oscillations. (02pts)

   (d) Determine the positive values of K such that all the poles of the closed-loop system are real. (03pts)

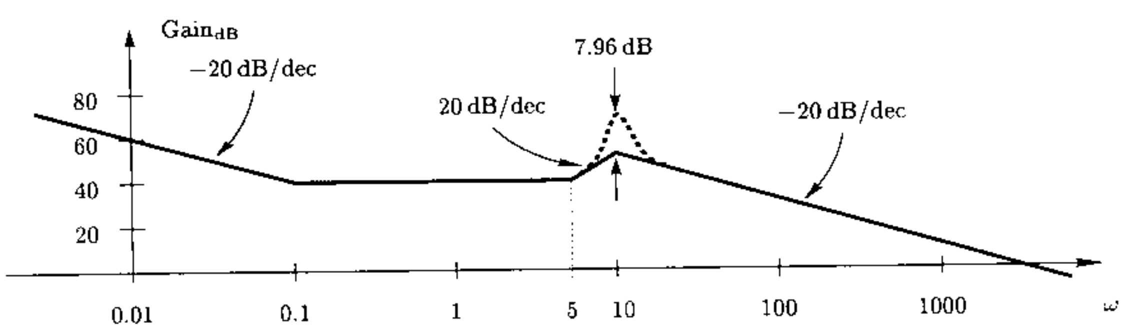
2. For the following system, design a first-order compensator $D(s)$, such that the closed-loop complex poles are at $s = -3 \pm j\,3\sqrt{3}$, and the steady state error is minimum. (20pts)



3. For the following feedback system, design a (possibly second-order) compensator $D(s)$, such that the closed-loop complex poles are at $s = -2 \pm j$ and the steady state error is less than 0.5. (30pts)



4. The frequency response of a minimum-phase, stable control system has been obtained experimentally, and the following asymptotes have been fitted.

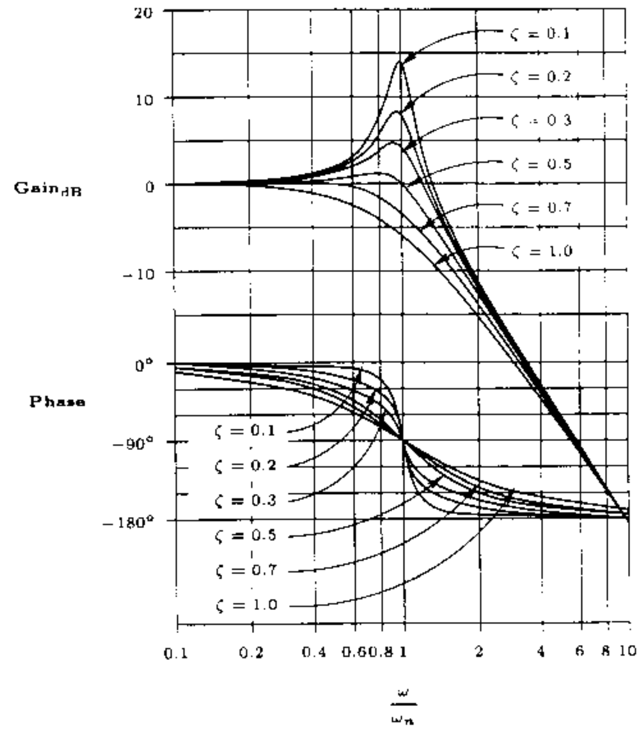


Determine the transfer function from the asymptotes. (20pts)

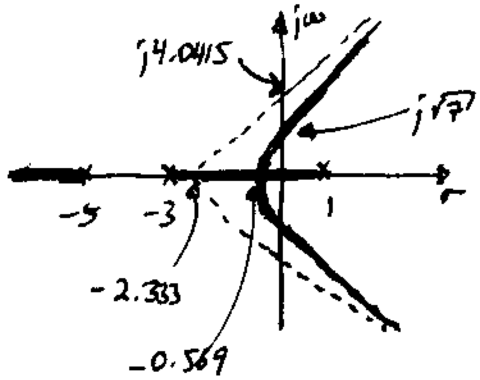
Make intelligent use of the figure on the right which shows the magnitude and phase versus frequency plots of

$$\frac{1}{(j(\omega/\omega_n))^2 + 2\zeta\,(j(\omega/\omega_n)) + 1}$$

for different values of ζ.



#1 a)



b) $15 \le K \le 64$

c) $K = 64$

d) $0 < K \le 16.9$

#2 $D(s) = 212.426 \dfrac{s+0.78}{s+46.126}$

#3 $D(s) = 0.03 \dfrac{s+1.883}{s+3.008} \cdot \dfrac{s+0.01}{s+0.0063}$

#4 $G(s) = \dfrac{10\left(\frac{s}{0.1}+1\right)\left(\frac{s}{5}+1\right)}{s\left(\frac{s^2}{100}+0.4\frac{s}{10}+1\right)}$