Hongik University, Fall 2020

Automatic Control System

Exam–1 (B) Due 5:30PM Today (Nov. 23rd, '20)

Submit your Exam here ⇒ acs_hu20 For questions, contact S.-H. Lee (shlee@ieee.org)

Rules:
1. Choose one of three types: type (A) if your number ends with 0,3,6,9, type (B) if your number ends with 1,4,7, and type (C), if your number ends with 2,5,8.
2. Take home
3. Closed Neighbor
4. Upload your report (PDF) with MATLAB files (please zip them) to acs_hu20.

Problem 1. Consider a process model

$$G(s) = \frac{s}{s/2+1}.$$

Assuming that a ramp input $u(t) = t$ is applied to the process,

a) Find the output $Y(s) = G(s)U(s)$;

b) Find the output $y(\infty)$, if exists. Give your reason;

c) Find the output $y(t)$. Compute $y(\infty)$.

Problem 2. You are given an equation

$$(s+1)^2 + Ks + 1 = 0.$$

You want to draw by hand a root locus for the solutions of the equation.

a) Compute asymptotes' angles, if any.

b) Compute asymptotes' intersections, if any.

c) Compute departure angles, if any.

d) Compute merging points, if any.

e) Compute departing points, if any.

Problem 3. You are given an open-loop TF

$$L(s) = \frac{s/10-1}{s(s/100+1)(s/1000+1)}.$$

You want to draw by hand the Bode plot of the TF.

a) The TF can be divided into fractions with corner frequencies for each. Give gain and phase asymptotes of each term at frequencies far away from its corner frequency.

b) Draw by hand the Bode curve of the TF, using the above results.

Problem 4: You are given an open-loop TF

$$L(s) = \frac{1}{s(s+1)(s+2)}K.$$

You want to use MATLAB to plot the poles of the closed-loop TF $T(s) = L(s)/(1+L(s))$ for K varying from 0 to 100. From the root locus, find the smallest value of K that causes the closed-loop to become unstable. (Just give a sufficiently accurate value).

Problem 5: You are given an open-loop TF

$$L(s) = \frac{1}{s(s+1)(s+2)}K.$$

Using MATLAB draw the Bode curve of the open-loop TF.

The closed-loop is described by $T(s) = L(s)/(1+L(s))$. Find the stability margins (GM [dB] and PM [deg]) of the closed-loop TF when $K = 1$.

Also find the stability margins (GM [dB] and PM [deg]) of the closed-loop TF when K takes the value in Problem 4.

Problem 6: You are given a process TF

$$G(s) = \frac{1}{(s/0.01+1)^2} \cdot \frac{\omega^2}{s^2 + 2\zeta\omega s + \omega^2}$$

with $\omega = 20\pi$ [rad/s] and $\zeta = 0.1$. The open-loop TF is given by $L(s) = G(s)K$. The closed-loop TF is described by $T(s) = L(s)/(1+L(s)) = G(s)K/(1+G(s)K)$.

Use MATLAB to give answers for the following questions:

a) Find K that causes the closed-loop to have PM ≈ 30 [deg] (Give your specific answer: K and resulting PM).

b) For the value of K, find GM [dB].

(Do not waste your time in finding unnecessarily accurate values. Just give sufficiently accurate values.)