ECE 3510 Exam 3 given: Spring 12

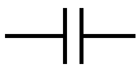
(The space between problems has been removed.)

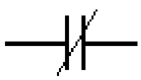
This part of the exam is Closed book, Closed notes, No Calculator.

Your answers should specific, clear, concise, and legible, or I'll assume you don't know.

1. (2 pts) Why are PID tuning methods used?

2. (3 pts) Give the meaning of the following ladder-logic symbols:

   a) 

   b) 

3. (6 pts) In the Basic PLL lab you designed something which later provided the impetus for the unconventional root-locus plot. In the Advanced PLL lab you improved this item

   a) What was it that you designed, and what two items was it hooked between?

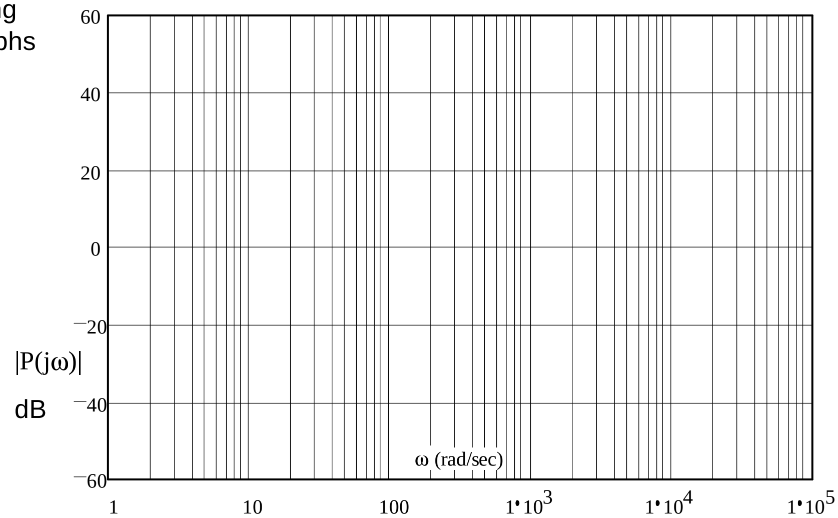
   b) At or near the end of both of these labs you tested your PLL at a specific task to see how well your filter was performing. What was the special task your PLL was performing?

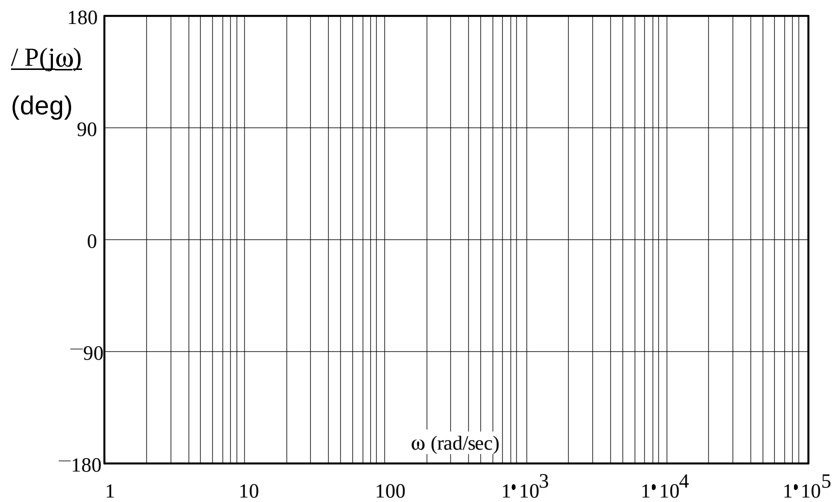
4. (16 pts) Below is a list of compensators. Give the common use of each compensator. Answer with the lettered answers given. Each blank may have more than one answer.

Compensator	Why Used?	Possible Answers (Compared to a simple proportional gain)
a) PI	___________	A. Essentially useless due to side effects
b) I	___________	B. Increase the speed of the system response
c) PD	___________	C. Decrease overshoot
d) D	___________	D. Decrease the settling time
e) PID	___________	E. Reduce the steady-state error
f) Lag	___________	F. Eliminate the steady-state error for a DC input
g) Lead	___________	G. Mostly reject constant disturbances
h) Lead/Lag	___________	H. Completely reject constant disturbances

1. (20 pts) Sketch the Bode plot for the following transfer function. Make sure to label the graphs as necessary to show the magnitudes and slopes. Also accurately draw the "smooth" lines. Include dB values at important points

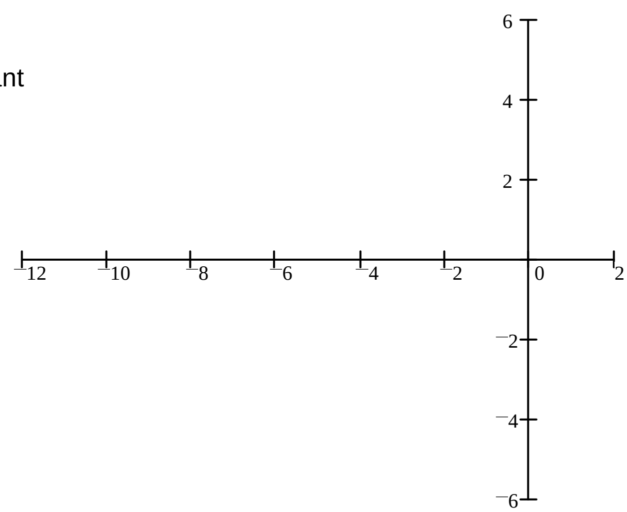
$$P(s) = \frac{(s+3000)\cdot 333\cdot s}{(s+5)\cdot\left(s^2+40\cdot s+10000\right)}$$





2. (20 pts) Sketch the unconventional root-locus plot for the open-loop transfer function below. The root-locus should be plotted for an increasing m.

$$G(s) = \frac{k\cdot(s+30)}{(m\cdot s+s-10)\cdot(s+4)} \qquad k = 2 \text{ and is constant}$$



b) Can you place a closed-loop pole on the real axis at -2?
If yes, find the value of m needed to place the pole at this location.
If no, indicate what you think the best point on the real axis is and find the value of m needed to place the pole at that location.

3. (20 pts) Consider this transfer function. $G(s) := \dfrac{100}{s(s+24)}$ In a unity-feedback system with only gain.

   a) Can the closed-loop poles be set to get ringing at 20 rad/sec and a settling time of 0.1sec?

   Justify your answer

   b) You wish to add a compensator to get the conditions of part a). Add a **lead** compensator so that you will be able to do this. Set the lead compensator's pole at -60.

   $C(s)$ = ?

   c) With the compensator in place and a closed-loop pole at the location desired in part b) What is the gain?

4. (13 pts) You have designed a compensator with the following:

   A pole at the origin   A zero at -2   A zero at -30   Gain of 12

   a) Draw the block diagram of a PID compensator. Use the factors k_P, k_I, and k_D as the respective gains.

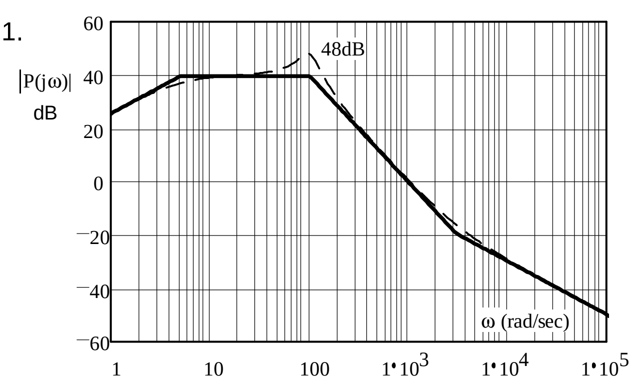
   b) Find the k_p, k_i, & k_d of the PID compensator.

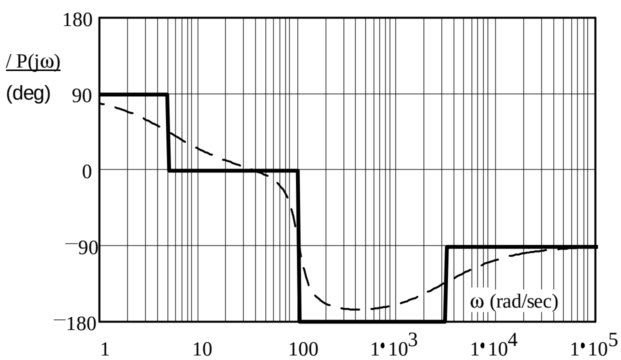
Answers

1. You'd like the benefits of a PID compensator, but the transfer function is unknown.
2. a) Normally-open switch or contact   b) Normally-closed switch or contact
3. a) The filter between the phase detector and the VCO   b) FM demodulation
4. a) F H   b) A   c) B C D   d) A   e) B C D F H   f) E G
   g) B C D   h) B C D E G

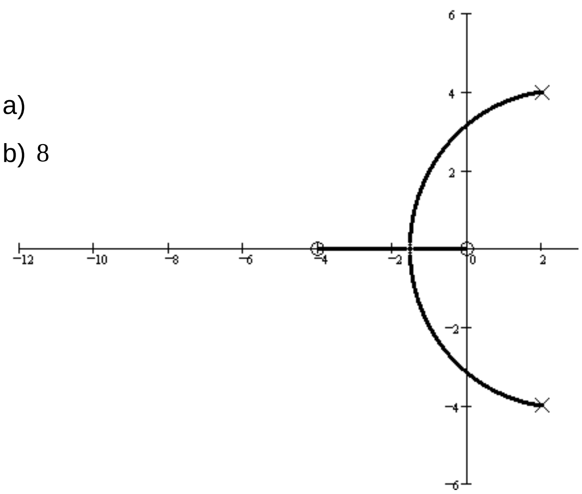
Open Book

1.





2. a)



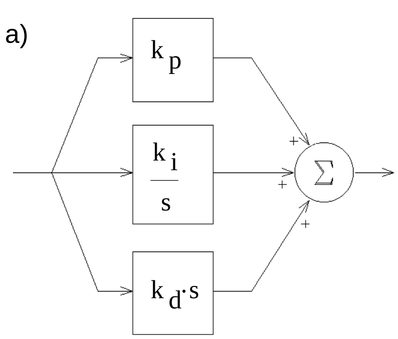
   b) 8

3. a) Desired location: $s := -40 + 20 \cdot j$

   No, the root locus doesn't pass through this point

   b) $C(s) := \dfrac{s+9.09}{s+60}$ c) 8.8

4. a)



   b) $k_d := 12$

   $k_i := 720$

   $k_p := 384$