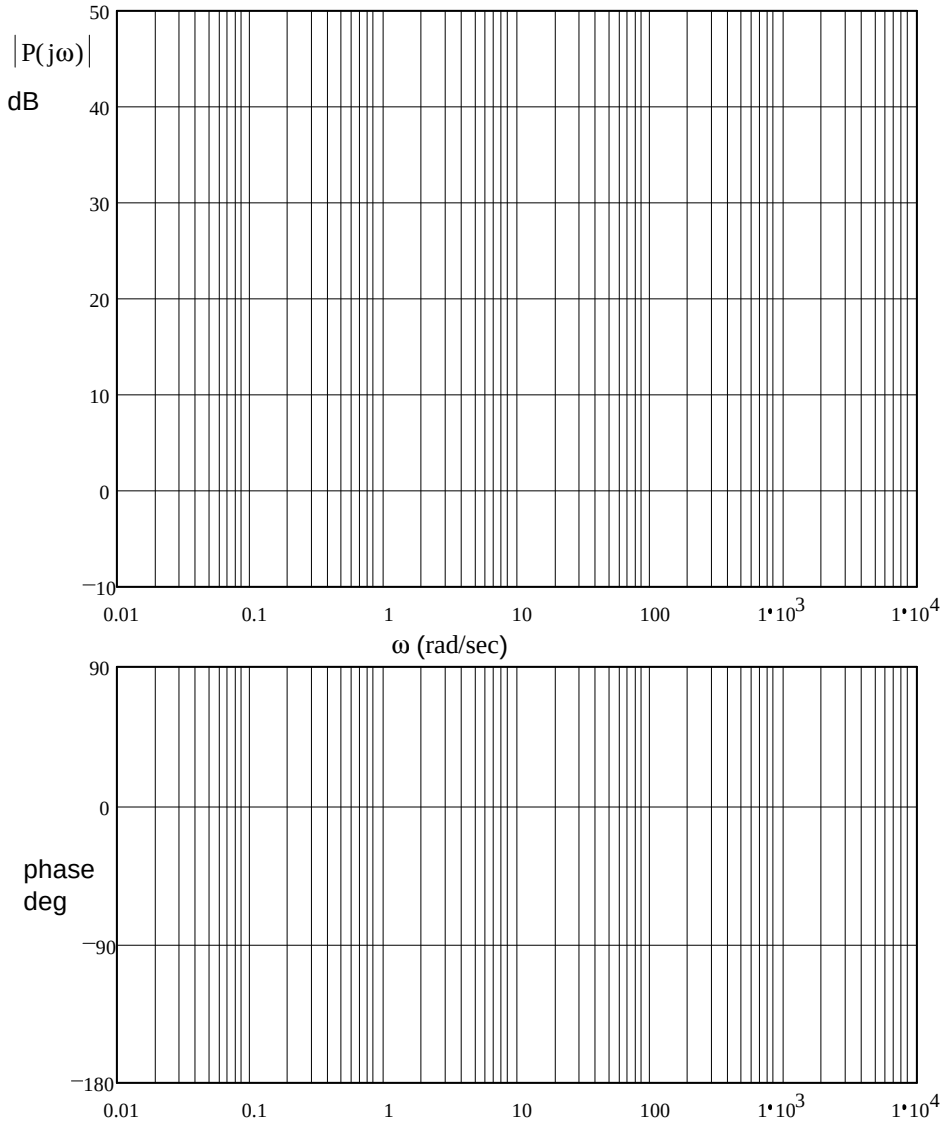
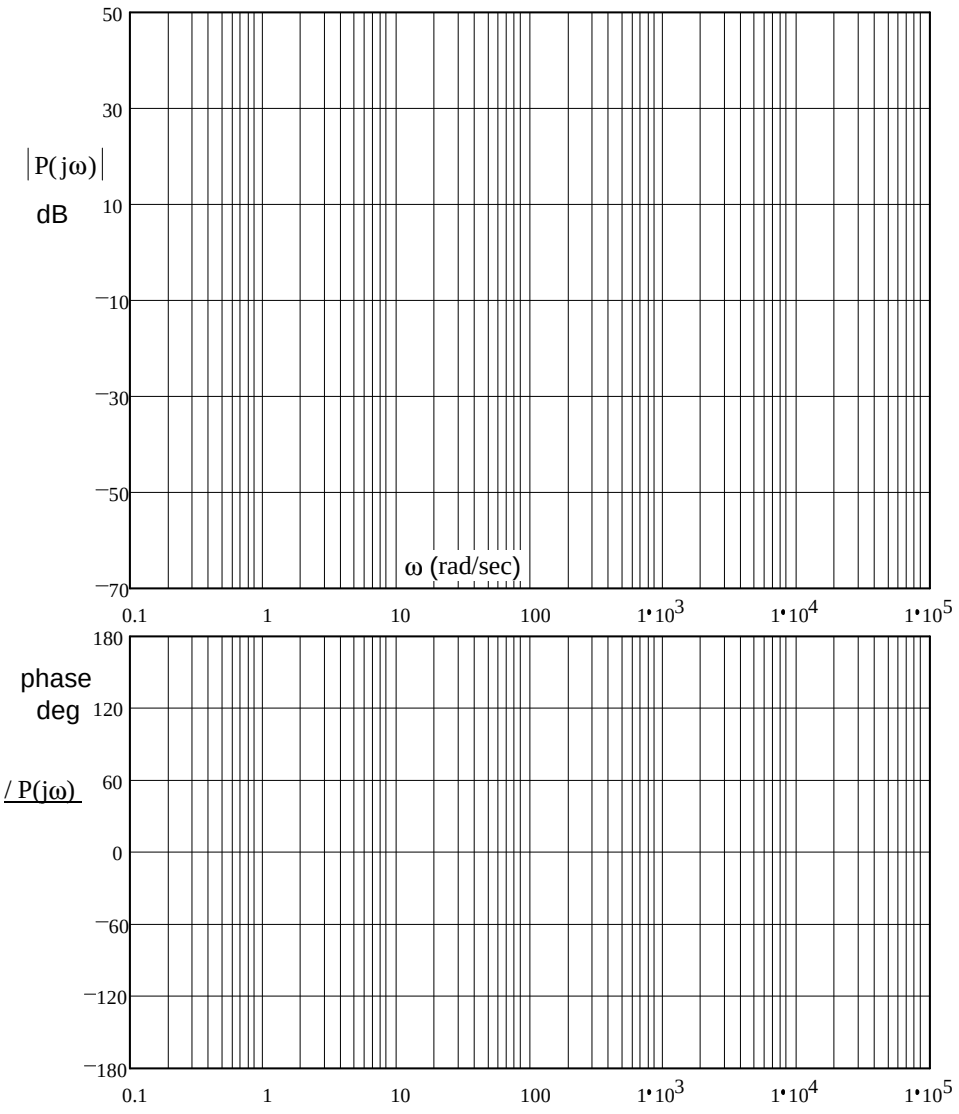
ECE 3510 Final given: Spring 19

1. (30 pts) Sketch the Bode plot for the following transfer functions. Use the method I taught in class to find magnitudes, slopes and angles and to check yourself. Also accurately draw the "smooth" lines.

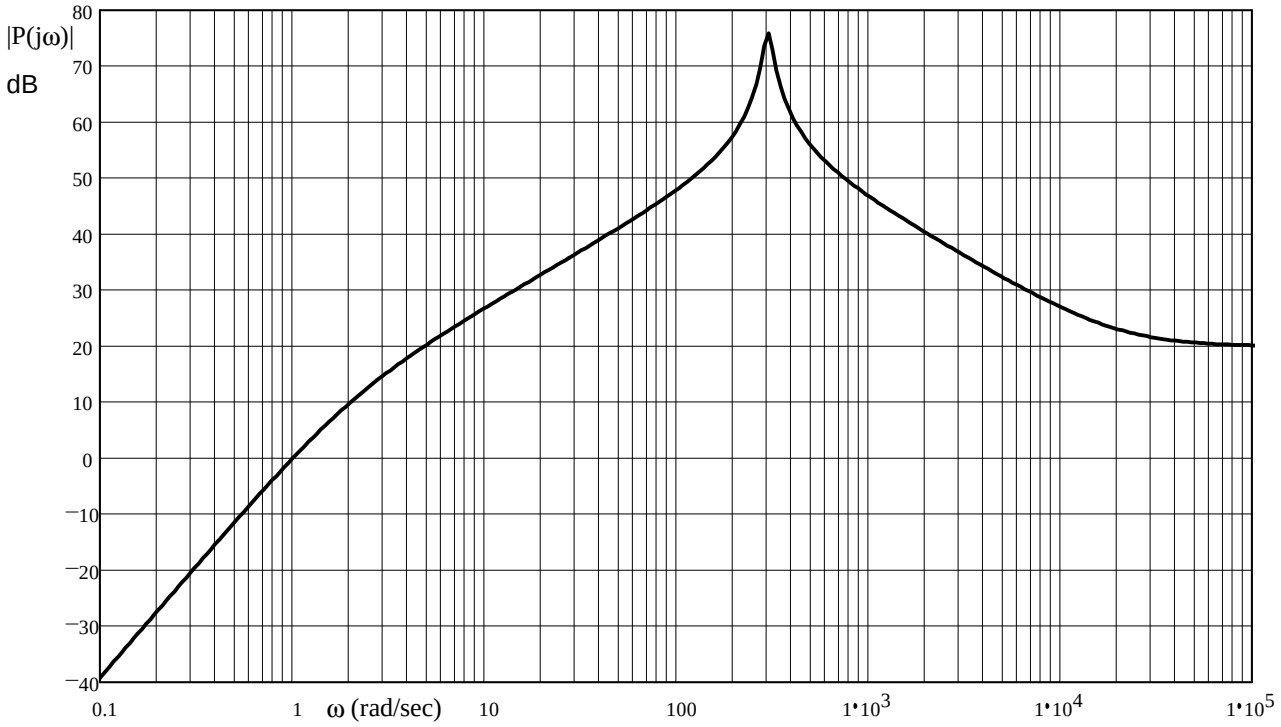
   a) $P(s) = \dfrac{2\cdot(s+0.1)^2\cdot(s+3000)}{s\cdot(s+2)\cdot(s+100)}$



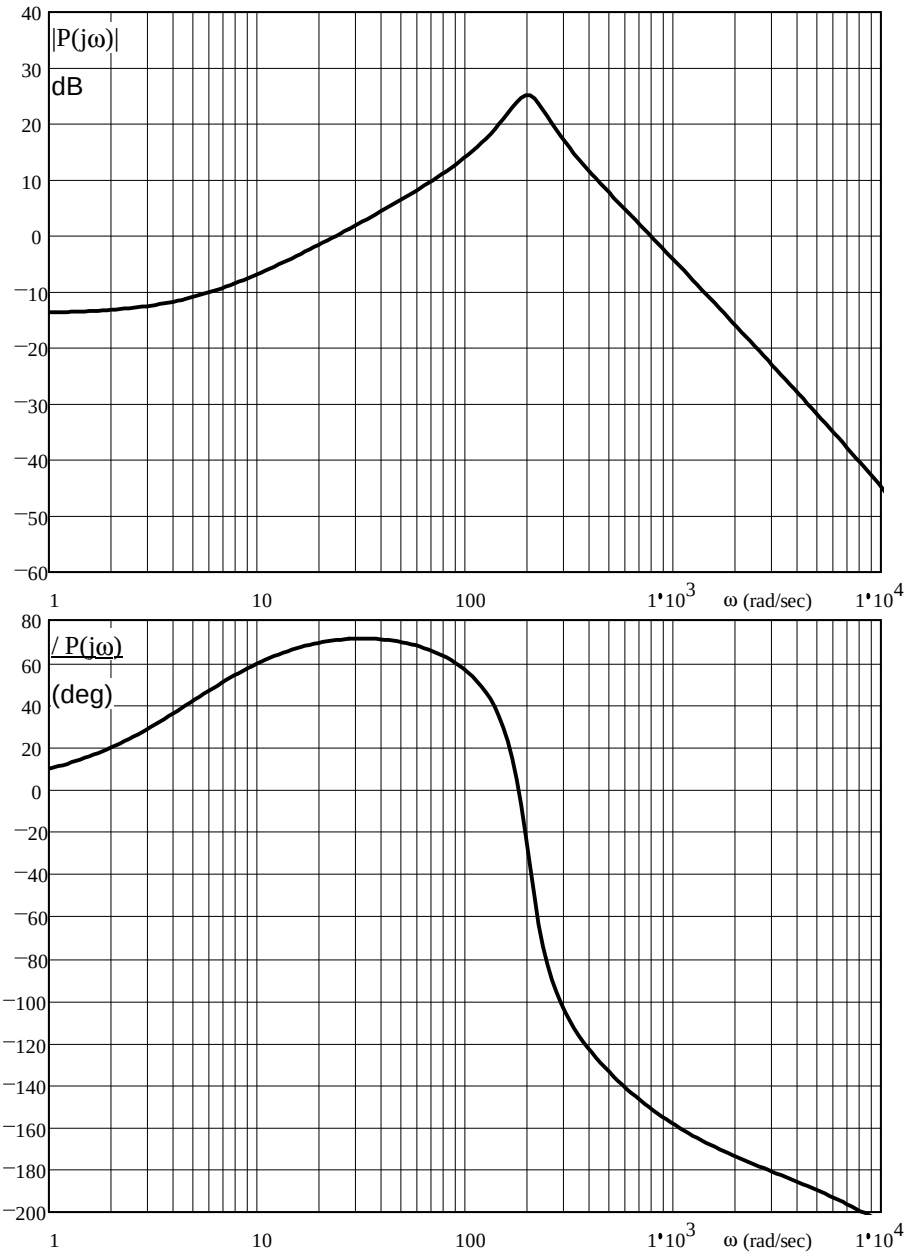
b) $P(s) = \dfrac{18000 \cdot \left(s^2 + 0.3 \cdot s + 9\right)}{\left[(s+20)^2 + 9600\right] \cdot (s+5000)}$



2. (18 pts) Given the magnitude Bode plot of a system, estimate the transfer function of the system.
   Assume there are no negative signs in the transfer function (all poles and zeros are in the left-half plane).
   Use a straight edge and show your work (how you made your estimate).



3. (18 pts) The open-loop Bode plots of a system are given at right.
   a) Find the gain margin and phase margin of the closed-loop system. Show your work on the drawings.



   b) Find the delay margin.

   c) For the system of part (a), give the steady-state response of the open-loop system an input $x(t) = 5\cos(10t)$. express the answer in the time-domain. $y_{ss}(t)$ = ?

4. (12 pts) When an electrical circuit is used as a representation if a mechanical system of translational motion, what do the following electrical quantities or parts represent in the mechanical system?

   a) Current =

   b) Voltage =

   c) Ground =

   d) Resistor =

   e) Inductor =

   f) Capacitor =

   i)

   Also:

   g) Is the capacitor always hooked up in a certain way? If yes, say what.

   h) Name two things represented by transformers. You may include items that rotate.

      1.

      2.

5. (30 pts) Use partial fraction expansion to find $x(k)$ for the following z-transforms:

   a) $X(z) = \dfrac{5 \cdot z \cdot (z - 0.4)}{(z - 1) \cdot (z + 0.5)}$

b) $X(z) = \dfrac{z^2}{(z+1)\cdot\left(z^2 - 1.4\cdot z + 0.98\right)}$

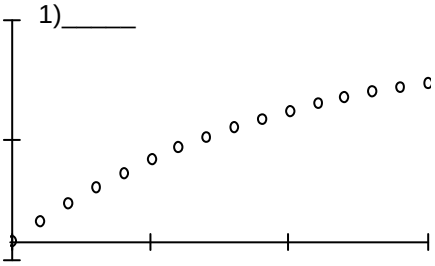
c) Is the signal represented by part b) bounded?

Does it converge?

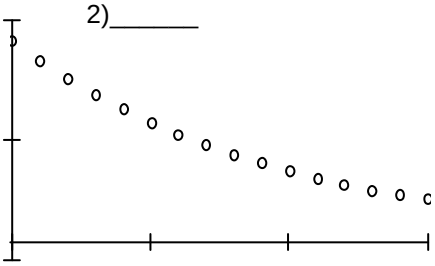
If yes, to what value?

6. (36 pts) a) Match each of the following discrete-time **signals** to one of the answers on the next page.
Each answer is a z-plane showing the unit circle and usually some poles
Find the single best match for each. Your answers should make sense relative to one another.

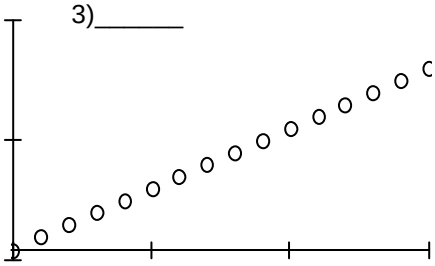
1)_____



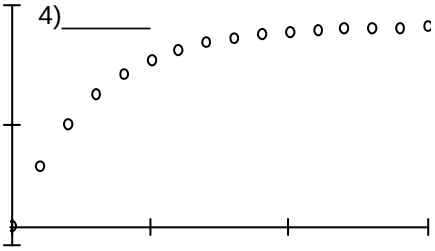
2)_____



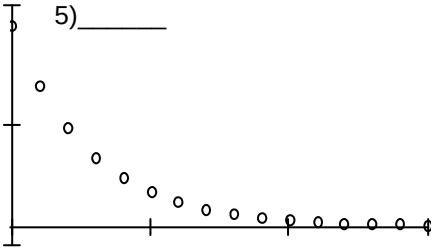
3)_____



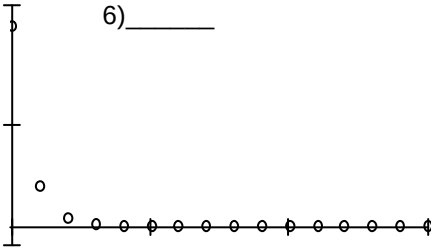
4)_____



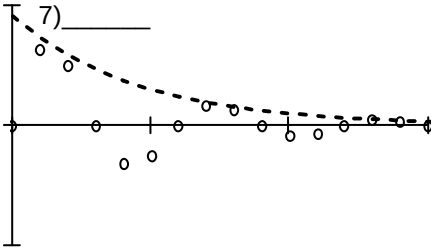
5)_____



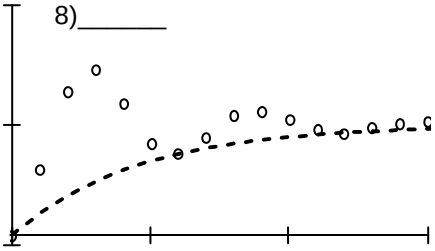
6)_____



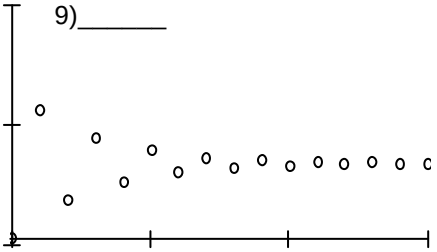
7)_____



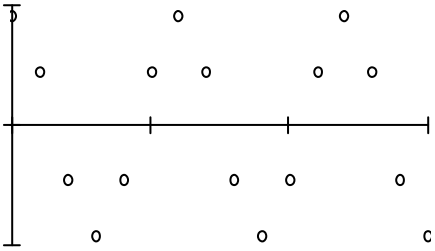
8)_____



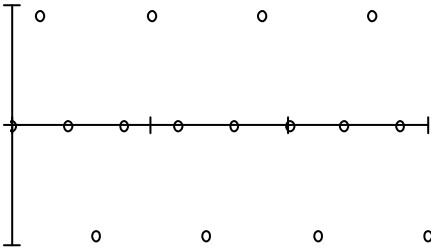
9)_____



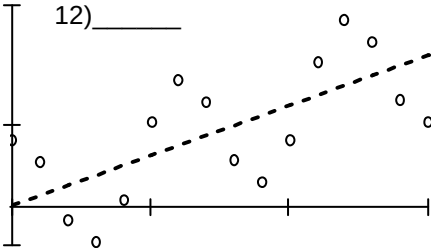
10)_____



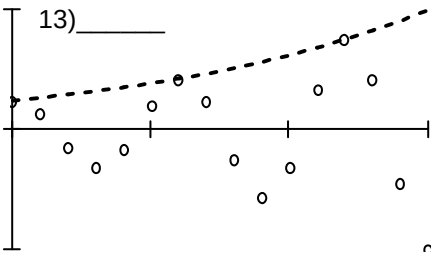
11)_____



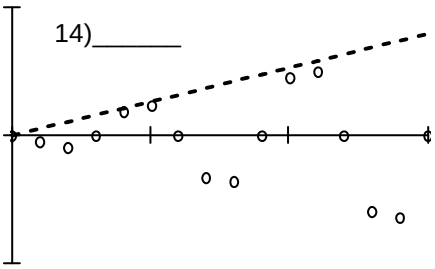
12)_____



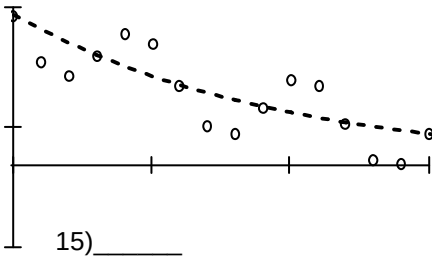
13)_____



14)_____



15)_____

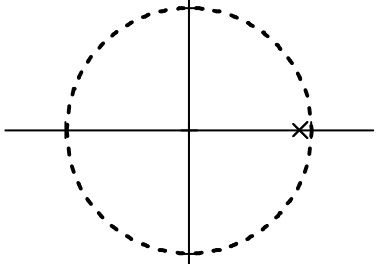


For parts b) and c), consider answers on the next page as poles of **transfer functions**.

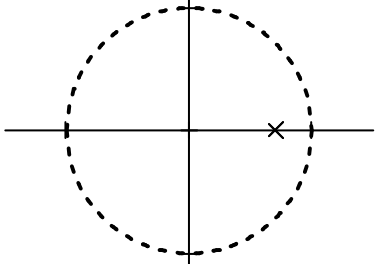
b) List all that are BIBO stable.

6 ANSWERS A **None of these answers match.** Answers may be used more than once or **not at all**.

B



C



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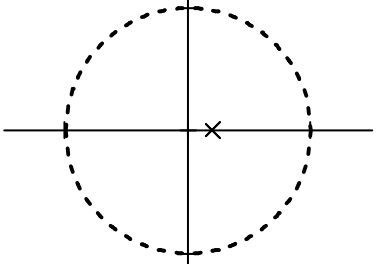
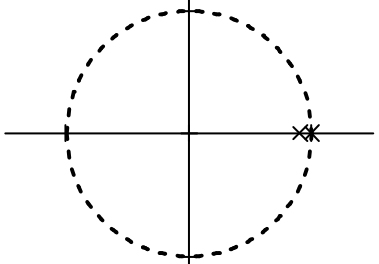
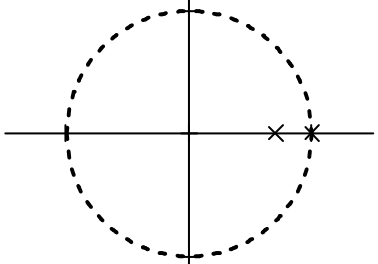


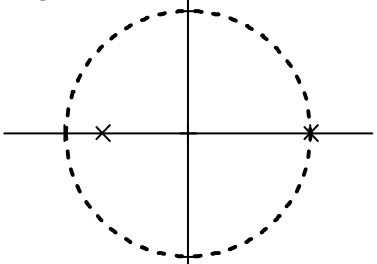
E



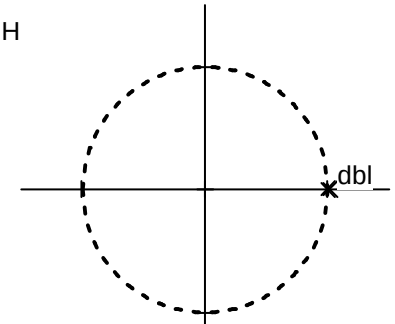
F



G

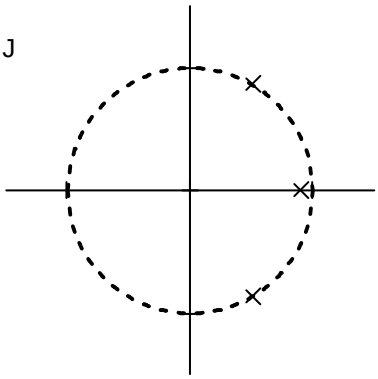


H

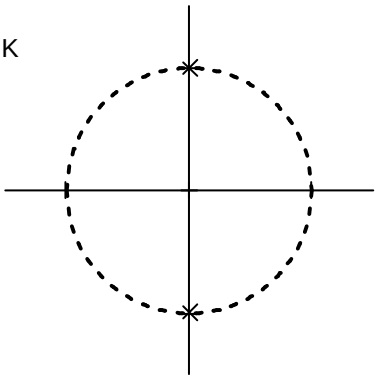


dbl = double pole

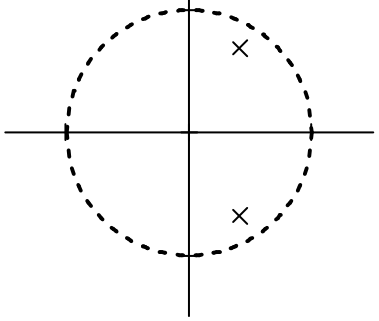
J



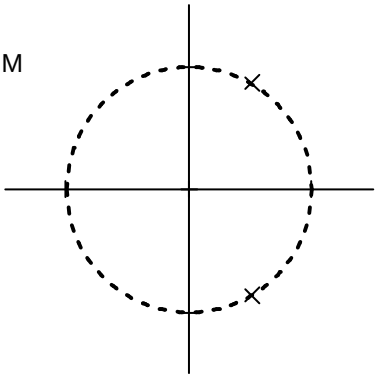
K



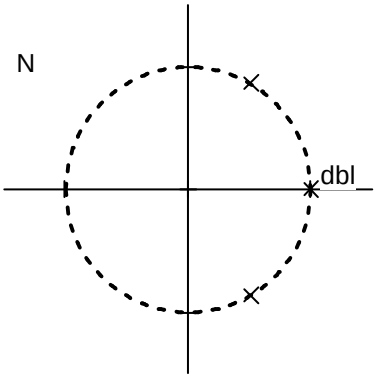
L



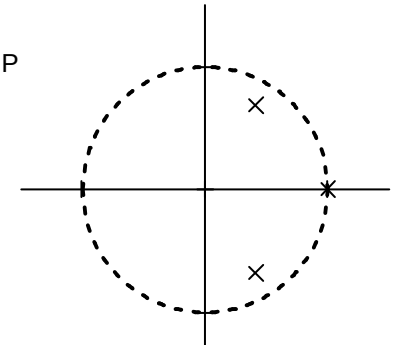
M



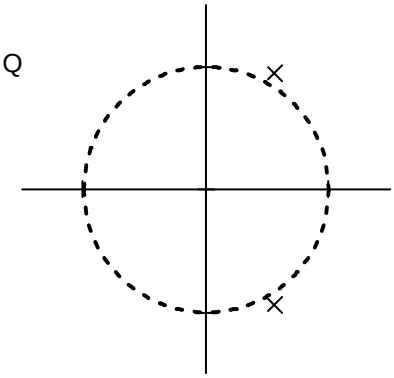
N



P

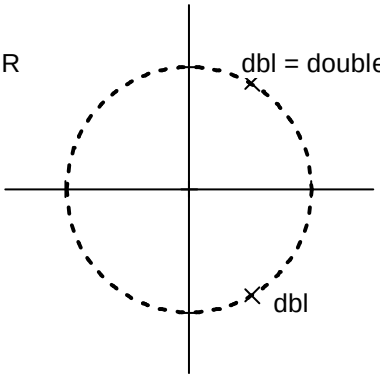


Q

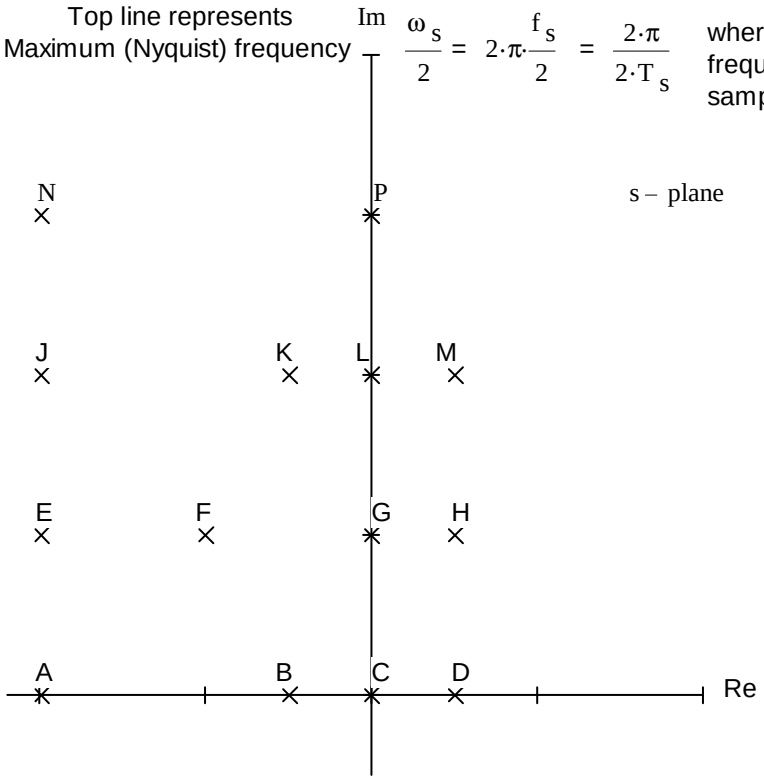


R

dbl = double pole

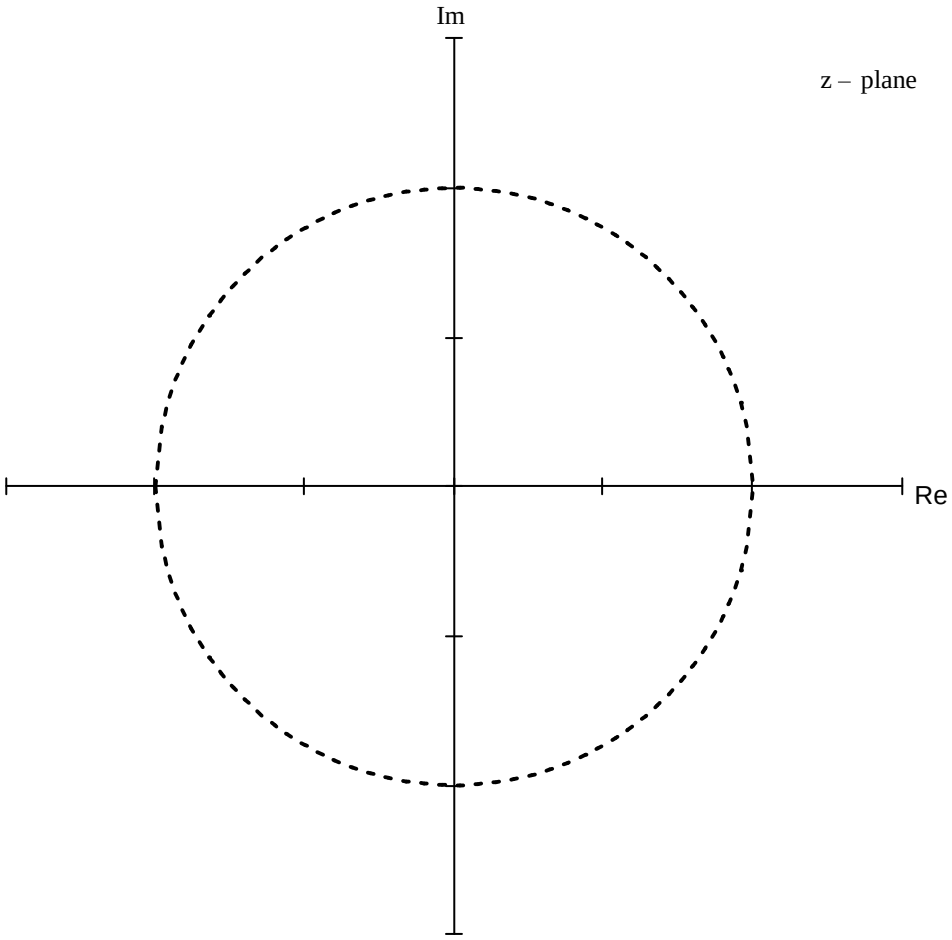


7. (20 pts) For each of the pole locations shown on the s-plane below, Draw and label a similar pole location on the z-plane.



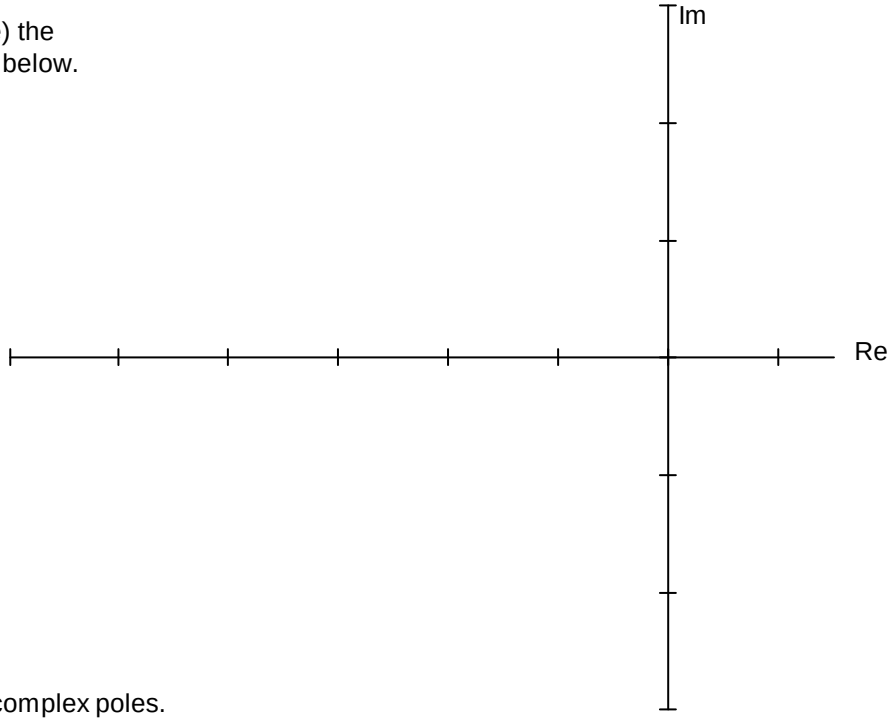
Note: The poles on both planes do come in complex-conjugate pairs, but I have only shown those above the real axis.

You may do the same below.



8. (16 pts) a) Lightly sketch (or use a dotted line) the root locus for the OL transfer function shown below.

$$G(s) = \frac{s+9}{(s+1)\cdot\left(s^2+4\cdot s+8\right)}$$



b) Find the departure angle from one of the complex poles.

c) Accurately draw the departure angle you found.

_____ / 16

Folder Number _____ _____ / 180 pts

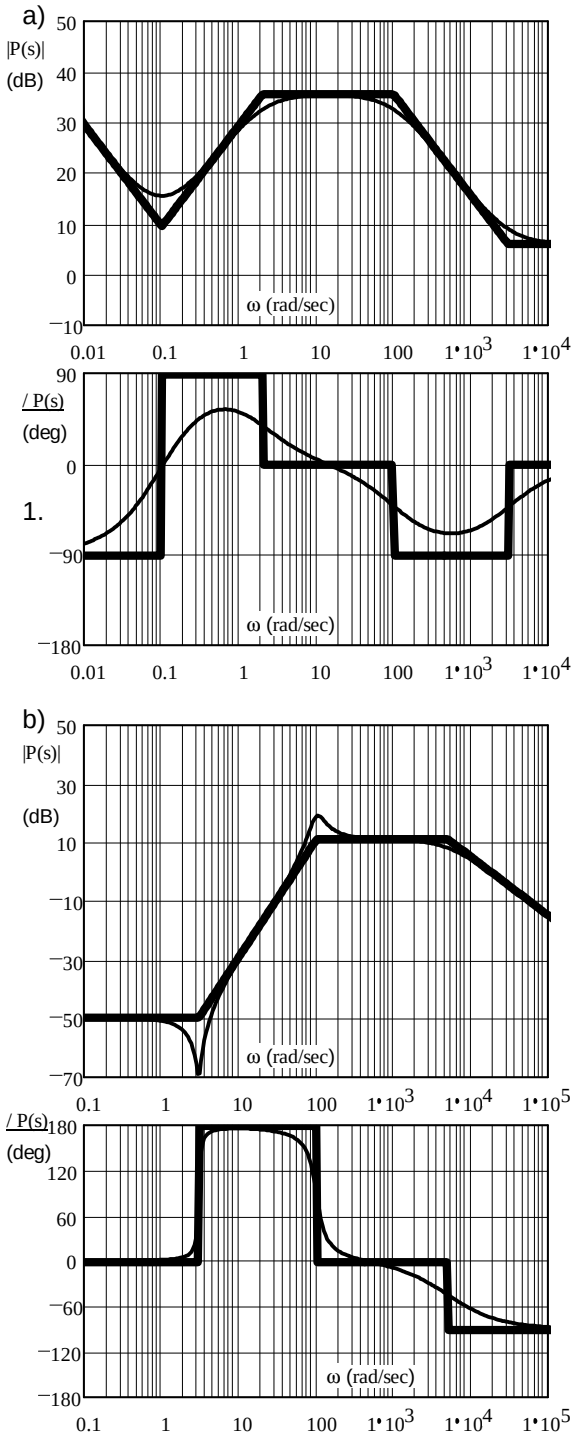
ECE 3510 Final Spring 19 p11

Do you want your grade and scores posted on the Internet?
If your answer is yes, then provide some sort of alias: _____
otherwise, leave blank

The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here.
I **will not** post grades under your real name or an alias that looks like a real name or u-number.
The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

Answers

1.



2. $\frac{10\cdot(s+20000)\cdot s^2}{(s+2)\cdot\left(s^2+32\cdot s+90000\right)}$

3. a) $23\cdot dB \quad 30\cdot deg$ b) $0.65\cdot ms$
c) $2.23\cdot\cos(10\cdot t+60\cdot deg)$

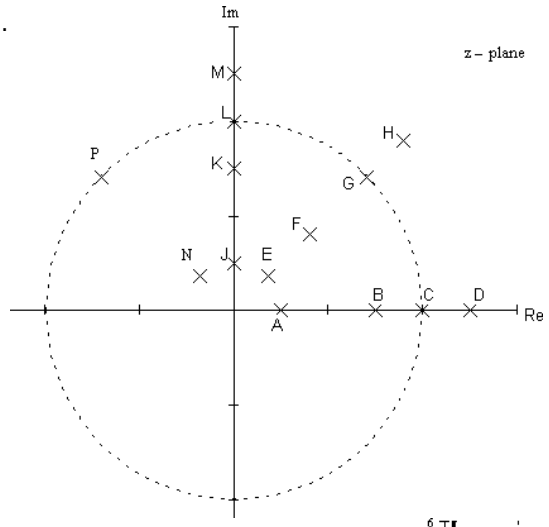
4. a) Force b) Velocity c) Stationary reference of zero velocity
d) Friction or damping e) Spring f) Mass
g) Yes, one side is always hooked to ground
h) Levers Wheels Belts Gears Electric motors 2 of these

5. a) $x(k) = \left[2+3\cdot(-0.5)^k\right]\cdot u(k)$ c) Yes Yes N/A

b) $x(k) := \left[-0.296\cdot(-1)^k+0.98^{\frac{k}{2}}\cdot\left(0.296\cdot\cos\left(\frac{\pi}{4}\cdot k\right)+0.71\cdot\sin\left(\frac{\pi}{4}\cdot k\right)\right)\right]\cdot u(k)$

6. a) 1) E 2) B
3) H 4) F
5) C 6) D
7) L 8) P
9) G 10) M
11) K 12) N
13) Q 14) R
15) J
b) B C D L

7.



8. b) $-10.6\cdot deg$ c)