MAE 3134: Homework 7

Due date: 13 April 2017, 0935

Problem 1 For each of the systems identified below, copmute the magnitude and angle of the transfer function when evaluated at the specified points in the imaginary plane (s-plane). You should use algebra to transform each function into a general complex number, then evaluate at each desired point. You must show your work for full credit. The magnitude should be reported in decibels (dB) and the angle in degrees.

1. Accelerometer model:

$$G(s) = \frac{X(s)}{F(s)} = \frac{0.5}{s^2 + 2s + 10}$$

   evaluated at the following points:

   (a) $s = j2$

   (b) $s = j3.1623$

   (c) $s = j2.8284$

2. Low-pass filter:

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{5}{s + 6}$$

   evaluated at the following points:

   (a) $s = j0.6$

   (b) $s = j6$

   (c) $s = j60$

3. High-pass filter:

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{s}{s + 35}$$

   evaluated at the following points:

   (a) $s = j2$

   (b) $s = j35$

   (c) $s = j500$

4. Lead filter:

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{0.21(s + 2)}{s + 3.05}$$

   evaluated at the following points:

   (a) $s = j0.247$

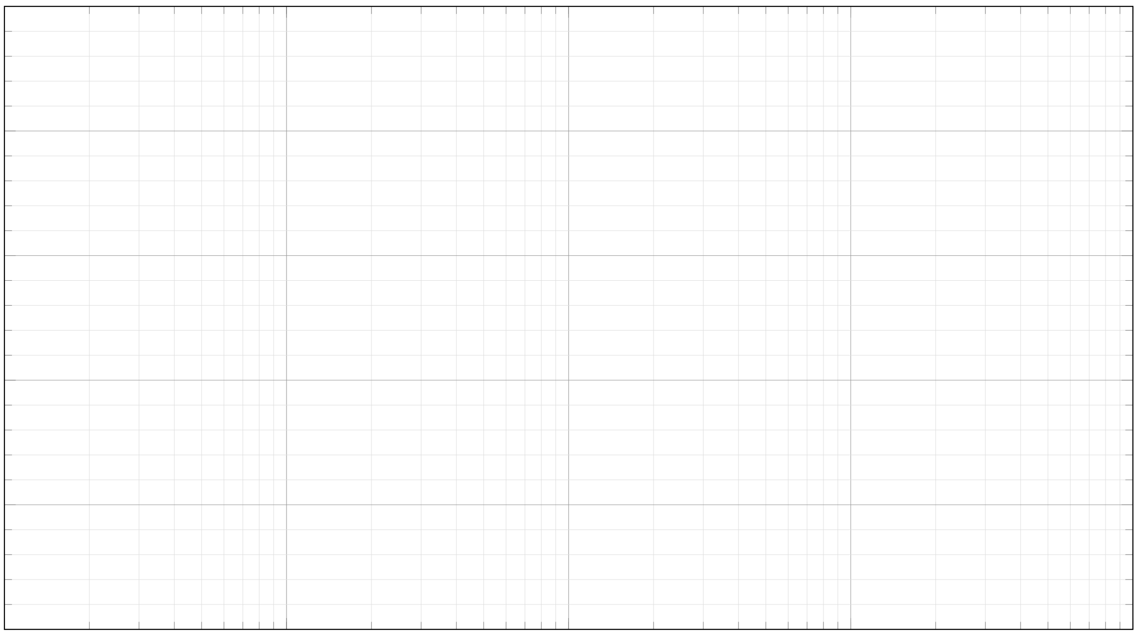
   (b) $s = j2.47$

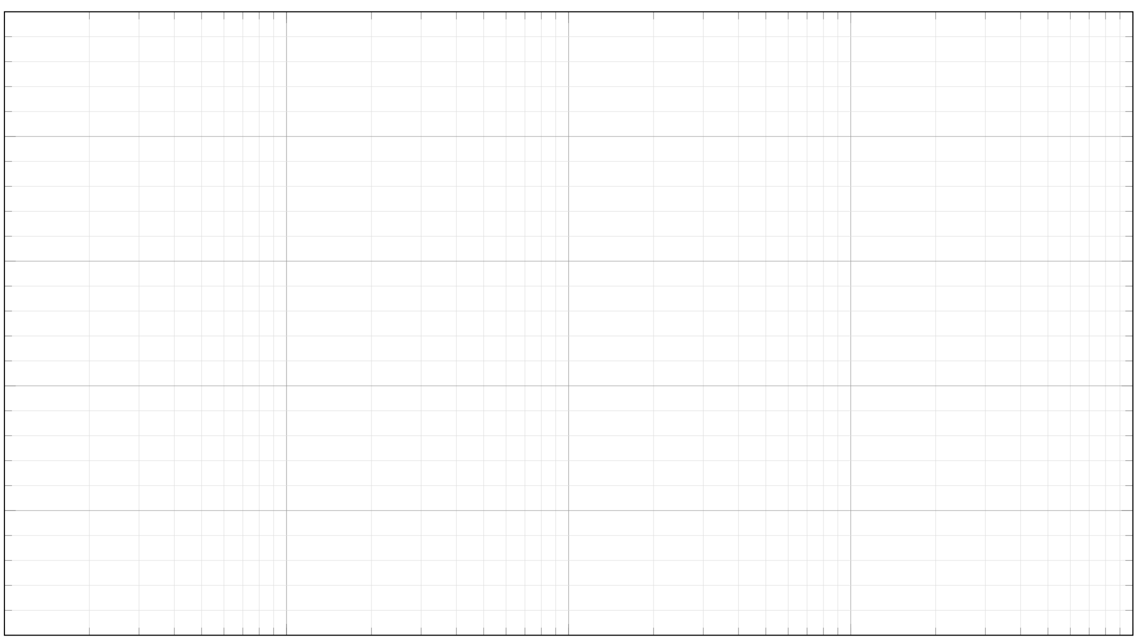
   (c) $s = j24.7$

You should produce HIGH quality Bode plots using the approximation tools learned in class. This means that you should use a ruler and write neatly and clearly.

Problem 2 Using the tranfer function of the **accelerometer model** given in Problem 1:

1. Draw an asymptotic Bode plot on the graphs provided.
2. Plot the true magnitude and phase of the specific points given previously.
3. Sketch your estimate of the actual Bode plot.

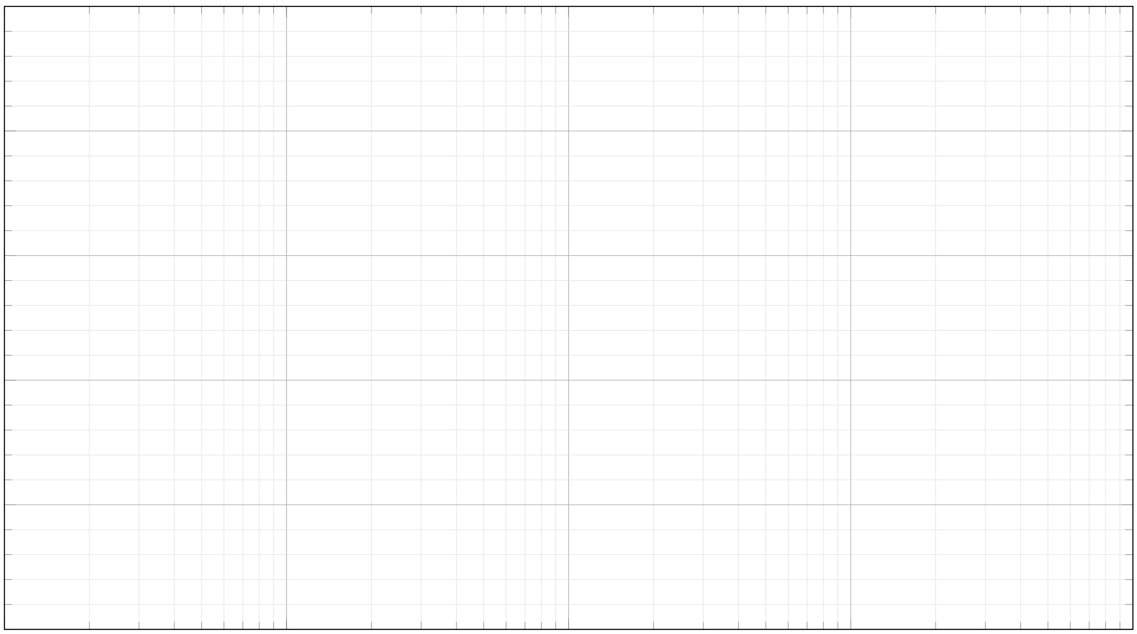


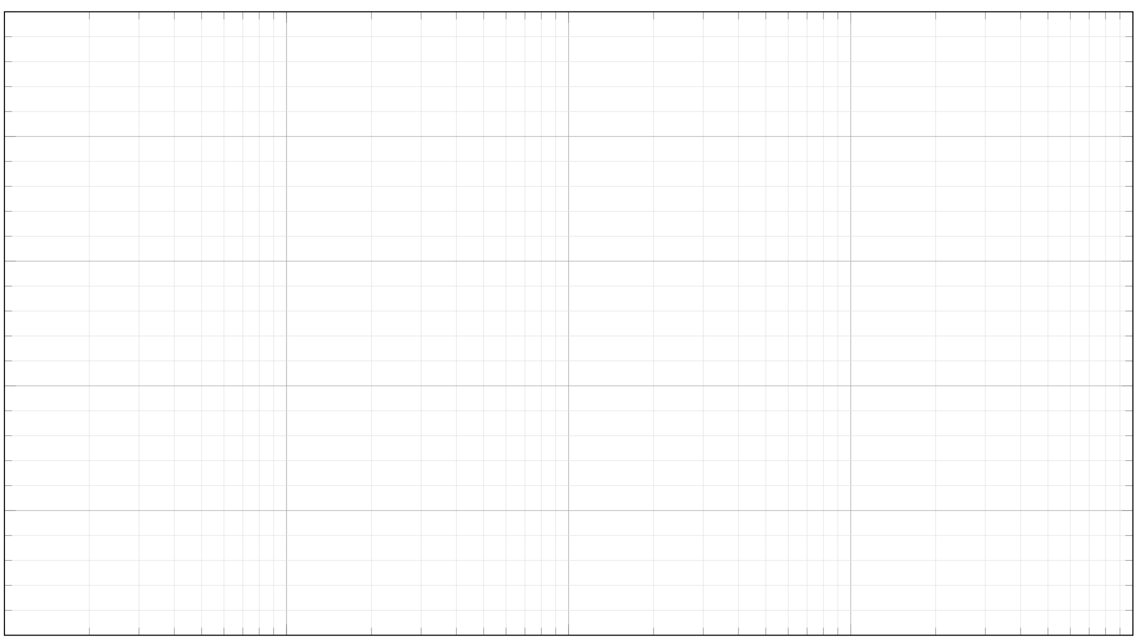


You should produce HIGH quality Bode plots using the approximation tools learned in class. This means that you should use a ruler and write neatly and clearly.

Problem 3 Using the tranfer function of the **low-pass filter** given in Problem 1:

1. Draw an asymptotic Bode plot on the graphs provided.
2. Plot the true magnitude and phase of the specific points given previously.
3. Sketch your estimate of the actual Bode plot.





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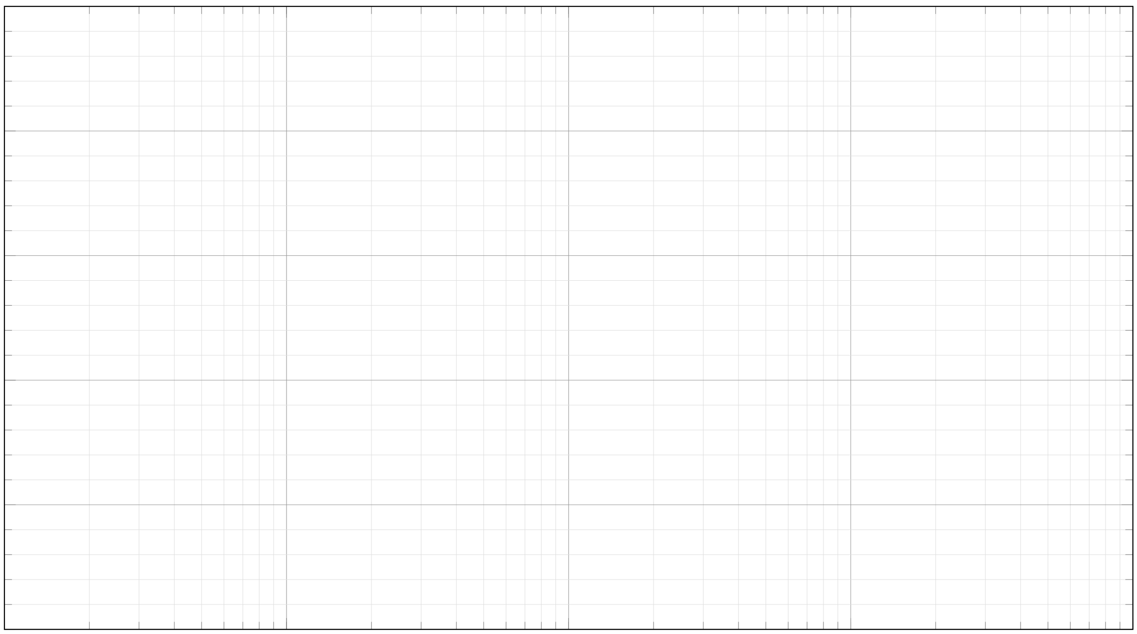
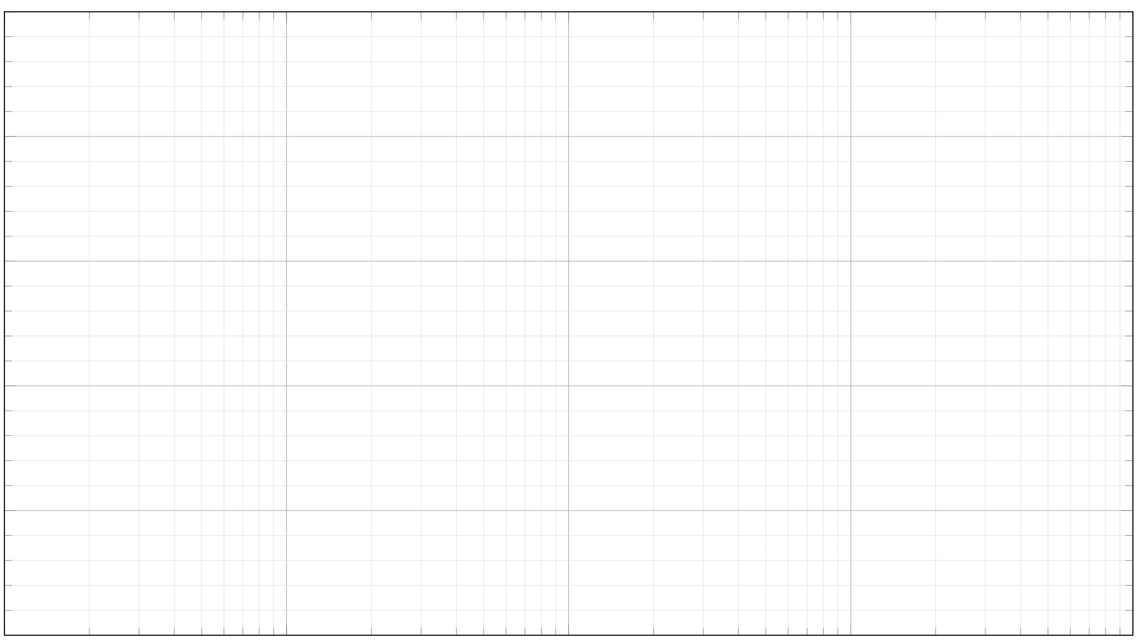
Problem 4 Using the tranfer function of the **high-pass filter** given in Problem 1:

1. Draw an asymptotic Bode plot on the graphs provided.
2. Plot the true magnitude and phase of the specific points given previously.
3. Sketch your estimate of the actual Bode plot.

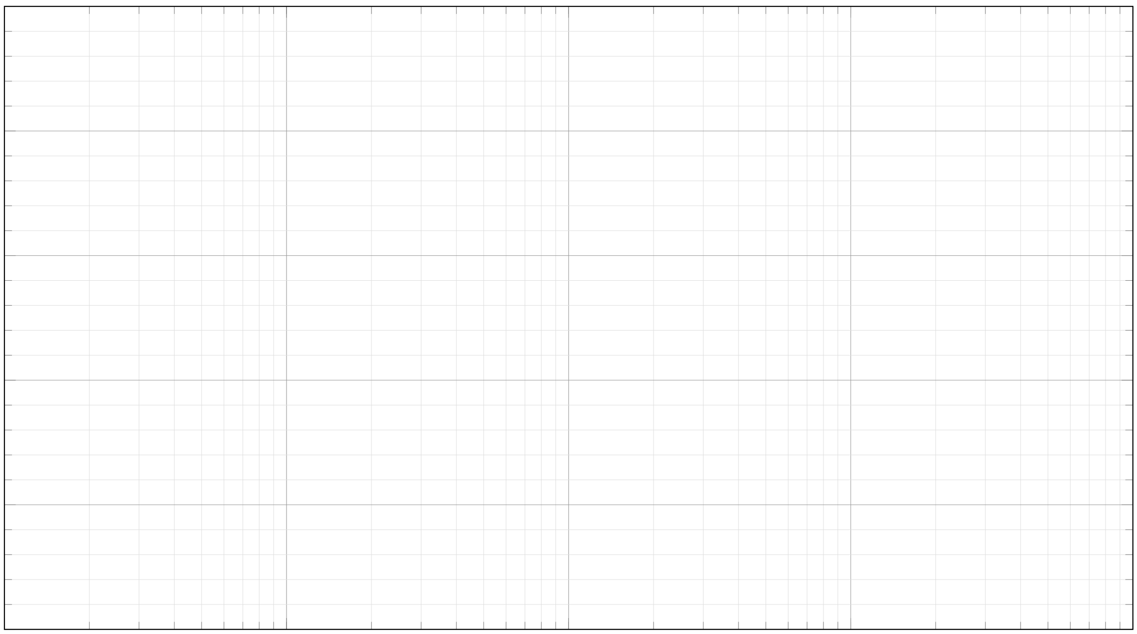


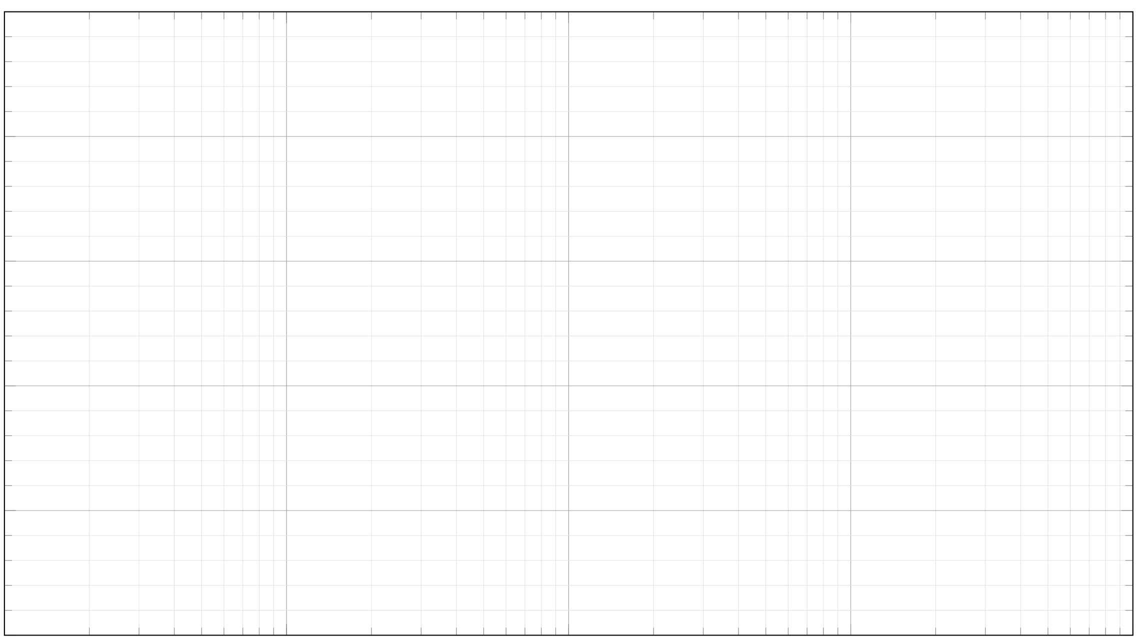


You should produce HIGH quality Bode plots using the approximation tools learned in class. This means that you should use a ruler and write neatly and clearly.

Problem 5 Using the tranfer function of the **lead filter** given in Problem 1:

1. Draw an asymptotic Bode plot on the graphs provided.
2. Plot the true magnitude and phase of the specific points given previously.
3. Sketch your estimate of the actual Bode plot.





Problem 6 Answer the following questions:

1. The model for a typical spring-mass-damper accelerometer is:

$$G(s) = \frac{X(s)}{F(s)} = \frac{0.5}{s^2 + 2s + 10}.$$

   If the input to this system is

$$f(t) = 17.333 \sin 2t,$$

   what is the steady-state output of the system?

2. We can model a low-pass filter as

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{5}{s + 6}.$$

   For the following inputs, determine the steady-state output of the system:

   (a) $v(t) = 10 \sin 0.6t$

   (b) $v(t) = 10 \sin 60t$

   Explain in your own words why this transfer funciton is called a "low-pass filter".

3. Now let's look at the high-pass filter modeled as

$$G(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{s}{s + 35}.$$

   Determine the steady-state output corresponding to these inputs:

   (a) $v(t) = 10 \sin 2t$

   (b) $v(t) = 10 \sin 500t$

   Explain in your own words why this transfer function is called a "high-pass filter".