Signals and Systems 2

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Lab #3: Filters and Bode diagrams

High-level objectives:

(a) Use the help system, to learn about Matlab commands and syntax.

(b) Explore and modify examples, to understand third-party code and to write your own.

(c) Get familiar with basic Matlab commands.

(d) Analyze examples of code and relate them with the theory.

(e) Introduce good working habits for creating and presenting reports.

The deliverable for each group consists of a **single .zip file**, including all the materials required at the different exercises, and well as the required manual calculations in paper. The document should be named (please, **be strict** on that, it will be processed automatically):

SiS2_Lab3_NameSurnameMember1_NameSurnameMember2.zip

Submit only **one document per group** to Aula Global.

1. **First-order CT filters**

   Analyze and understand the following code:

```
syms s w;

% filter1
a = 1e4;
Hs = a/(s+a);
Hw = subs(Hs,s,j*w);
Hwm = 20*log10(abs(Hw));
ax = subplot(121); fplot(Hwm); hold on;
plot(a,-3,'.b','MarkerSize',15);
title('Filter 1'); xlabel('\omega (rad/s)'); ylabel('Mag.  H(j\omega) (dB)');
axis([10 10^5 -20 0]); ax.XScale = 'log';
ax.XTick = [10 1e2 1e3 1e4 1e5];
ax.XTickLabel = {'10','10^2','10^3','10^4','10^5'};
ax.YTick = [-20 -3 0];
ax.YTickLabel = {'-20','-3','0'};
grid on;

% filter2
a = 1e2;
Hs = s/(s+a);
Hw = subs(Hs,s,j*w);
Hwm = 20*log10(abs(Hw));
ax = subplot(122); fplot(Hwm); hold on;
plot(a,-3,'.b','MarkerSize',15);
title('Filter 2'); xlabel('\omega (rad/s)'); ylabel('Mag.  H(j \omega) (dB)');
axis([10 10^5 -20 0]); ax.XScale = 'log';
ax.XTick = [10 1e2 1e3 1e4 1e5];
ax.XTickLabel = {'10','10^2','10^3','10^4','10^5'};
ax.YTick = [-20 -3 0];
ax.YTickLabel = {'-20','-3','0'};
grid on;
```

   Based on what you've learnt, and the concepts from theory:

   (a) **Sketch**[1] the zero-pole diagrams of both filters.

   (b) **Sketch** the asymptotic approximation of the Bode diagrams (only magnitude) corresponding to filter1 and filter2, **annotating** the relevant points and characteristics.

   (c) **Determine** the transfer function of the system resulting from cascading filter1 and filter2.

   (d) **Sketch** the zero-pole diagram of the cascading system.

   (e) **Determine and sketch** the asymptotic approximation of the Bode diagram (only magnitude) corresponding to the cascading system, **annotating** the relevant points and characteristics.

   (f) **Write the code**[2] that **creates and plots**, in an **explanatory way**, the Bode

[1] **In a paper sheet (to be delivered at the end of the session)**, taking a picture for your personal use.
[2] Create a **script**, named as **Lab3-1.m**. Add it to the final .zip file.

diagram (only magnitude) of the cascading system, **annotating** the relevant points.

(g) **Determine** the order of the cascading system.

2. **First-order CT filters**

   Now consider a system comprised of the same two filters as in the previous exercise, but **interchanging the cut frequencies between the LPF and the HPF**. Based on what you've learnt so far, and the concepts seen in theory:

   (a) **Determine** the transfer functions of both filters.

   (b) **Sketch** the zero-pole diagrams of both filters.

   (c) **Sketch** the asymptotic approximation of the Bode diagrams (only magnitude) corresponding to filter1 and filter2, **annotating** the relevant points and characteristics.

   (d) **Determine** the transfer function of the system resulting from cascading filter1 and filter2.

   (e) **Sketch** the zero-pole diagram of the cascading system.

   (f) **Determine and sketch** the asymptotic approximation of the Bode diagram (only magnitude) corresponding to the cascading system, **annotating** the relevant points and characteristics.

   (g) **Write the code**[3] that **creates and plots**, in an **explanatory way**, the Bode diagram (only magnitude) of the cascading system, **annotating** the relevant points.

   (h) **Compare the zero-pole and Bode plots** of the cascading systems in Exercise1 (e,f) and Exercise2 (e,f).

3. **Second-order CT filters**

   From the cascading system of Exercise1:

   (a) **Design and sketch** a system that has the same pass-band characteristics as in Exercise1, but doubling the slopes of the rejection bands.

   (b) **Write the code**[4] that **creates and plots**, in an **explanatory way**, the Bode diagram (only magnitude) of the system, **annotating** the relevant points.

[3] Create a **script**, named as **Lab3-2.m**. Add it to the final .zip file.
[4] Create a **script**, named as **Lab3-3.m**. Add it to the final .zip file.