ECE 4213/5213
Homework 10

Work the Projects and Questions in Chapter 6 of the course laboratory manual.

For your report, use the file LABEX6.doc from the course web site.

Work these questions only:

1. Q6.2
2. Q6.3
3. Q6.5
4. Q6.7
5. Q6.8
6. Q6.11
7. Q6.12

NOTES:

1. You will have to make block diagrams for many of these questions. It is perfectly fine to draw them by hand and then scan them to get them into your report file. Alternatively, you can make them with a drawing program. That will make them look better, but it will take longer. For the solution, I used the Linux/X windows program *xfig*.

2. The transfer function $H_1(z)$ for Q6.3 is given in eq. (6.27) on page 103. To draw the diagram, you need use Program P6_1 to find the parameters p_0, α_{mn}, and β_{mn} shown in eq. (6.8) on page 95 of the Lab manual and you need to use them to draw a diagram like the one at the bottom of page 95. The indices on α and β work like this: β_{mn} is the m'th β coefficient in the n'th second order section. Similarly, α_{mn} is the m'th α coefficient in the n'th second order section.

   Reading the numerator and denominator coefficients from $H_1(z)$ in eq. (6.27), you get `num = [3 8 12 7 2 -2]` and `den = [16 24 24 14 5 1]`.

   Program P6_1 calls the Matlab routine `zp2sos`, which outputs a matrix of the paramters in the following form:

$$
\begin{array}{cccccc}
p_0 & p_0\beta_{11} & p_0\beta_{21} & 1 & \alpha_{11} & \alpha_{21} \\
1 & \beta_{12} & \beta_{22} & 1 & \alpha_{12} & \alpha_{22} \\
1 & \beta_{13} & \beta_{23} & 1 & \alpha_{13} & \alpha_{23}
\end{array}
$$

Note that you still have to divide by p_0 to get β_{11} and β_{21} from this.

For example, in Q6.3 the matrix you get back from Program P6_1 is:

```
sos =

    0.1875   -0.0625        0    1.0000    0.5000        0
    1.0000    2.0000   2.0000    1.0000    0.5000    0.2500
    1.0000    1.0000   1.0000    1.0000    0.5000    0.5000
```

From this, we get $p_0 = 0.1875 = 3/16$, $\beta_{11} = -0.0625/0.1875 = -1/3$, and $\beta_{21} = 0/0.1875 = 0$. The rest of the α's and β's can be read directly from the returned `sos` matrix.

3. All that is required for Q6.7 is to call the Matlab routine `poly2rc` with the coefficients of the denominator polynomial. The question tells you to use program P4_4 (see p. 70 of the Lab Manual). But there is nothing special about that program other than the fact that it calls `poly2rc` to compute the reflection coefficients (lattice parameters) k_i.

   - The Matlab help for `poly2rc` warns you that normalization will be applied if the leading denominator coefficient d0 is not equal to "1." This may bother you, since the leading denominator coefficient in (6.29) is 16, not 1. The reason it is 16 is because this makes all the numbers in (6.29) look nicer.

   - But it's perfectly fine to call `poly2rc` with the numbers exactly as they are given in the denominator of (6.29). While it is true that `poly2rc` will divide them all by 16, this won't change the reflection coefficients k_i at all.

   - Once you use `poly2rc` to find the reflection coefficients, you can implement the filter structure as in Fig. 6.12(b).

   - To answer the stability question, you can look back at R4.32 on p. 61 of the Lab Manual. The same result is stated more clearly on p. 8-44 of the course notes and in (6.18) on p. 98 of the Lab Manual.

4. Similar comments apply to question Q6.8.

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