Introduction to Time-Varying Electrical Networks : Week 6

Problem 1

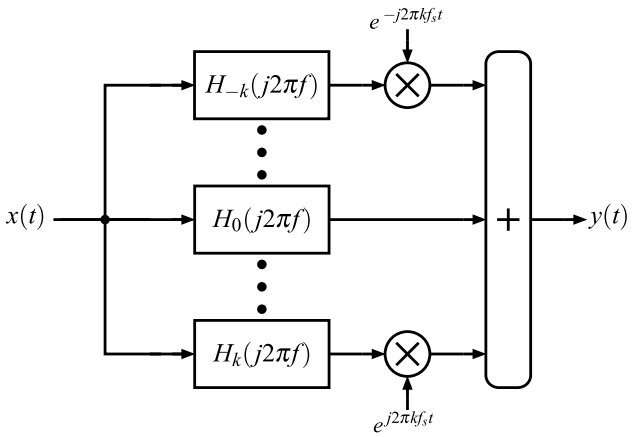

Figure 1: Zadeh expansion of an LPTV system.

The figure above shows the Zadeh expansion of an LPTV network, where k ranges from $-\infty$ to ∞.

a. Are the impulse responses corresponding to $H_k(j2\pi f)$ real or complex?

b. What is the relationship between the impulse responses of the filters $H_k(j2\pi f)$ and $H_{-k}(j2\pi f)$ for a given k?

c. Suppose that $x(t) = \cos(2\pi ft)$. Determine the output of the branches containing $H_k(j2\pi f)$ and $H_{-k}(j2\pi f)$. Also determine their sum. Repeat the exercise above for $x(t) = \sin(2\pi ft)$. What do you conclude?

Problem 2

Fig. 2 shows an alternative representation of an LPTV system. How are the $F_k(j2\pi f)$ related to the $H_k(j2\pi f)$ of Fig. 1?

Problem 3

Fig. 3 shows an LPTV system. Determine its Zadeh expansion.

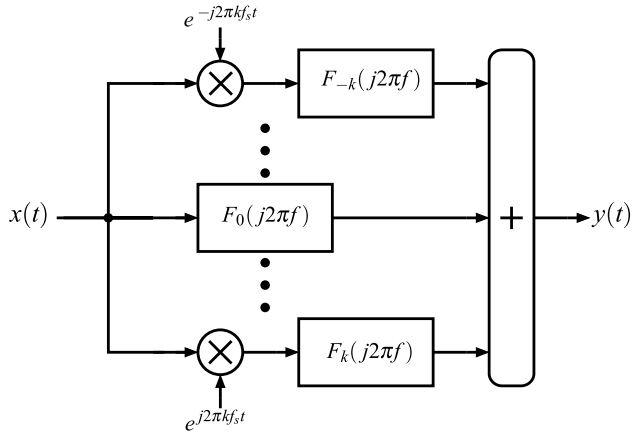

Figure 2: Alternative representation of an LPTV system.

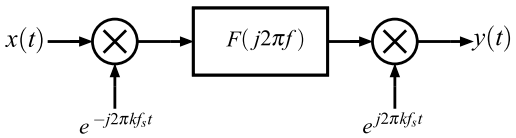

Figure 3: LPTV system for problem 3.

Problem 4

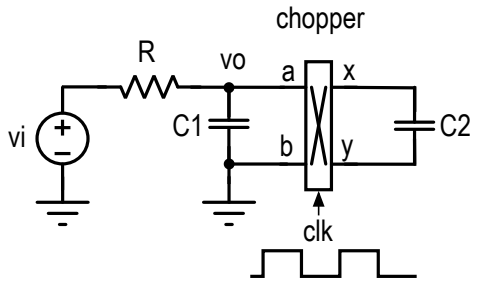

Figure 4: LPTV system for problem 4.

The circuit shown above is an LPTV network. The chopper is a network of ideal switches that works as follows. When clk is high, nodes a and b are connected to nodes x and y respectively. When clk is low, nodes a and b are connected to nodes y and x respectively. The clk signal has a 50% duty cycle and frequency f_s. Denote the zeroth order harmonic transfer function from vi to vo by $H_0(j2\pi f)$. Determine $H_0(0)$.