Introduction to Time-Varying Electrical Networks : Week 9

Problem 1

Prove the transfer-function theorem and frequency-reversal theorems for LPTV circuits. (Yes, I know - it was done in class, but do it anyway - on your own, without referring to the lecture now).

Problem 2

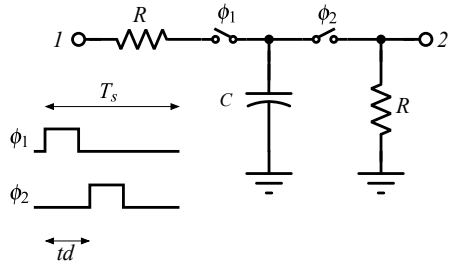

Figure 1: Two-port for problem 8.

Fig. 1 shows a two-port network consisting of resistors, ideal periodically-operated switches and a capacitor. The switch-control signals have a period $T_s = 1\,\text{s}$, having 25% duty cycle. Choose R=1Ω and C=10 F. The delay between ϕ_1 and ϕ_2 is td. Let $H_0(j2\pi f)$ denote the voltage gain from port 1 to port 2 (zeroth-order HTF) when $v_1 = e^{j2\pi ft}$. Further, let $\hat{H}_0(j2\pi f)$ denote the current gain from port 2 to port 1 (zeroth-order HTF) when $i_2 = e^{j2\pi ft}$. (Obviously, port 1 is shorted for this test). In other words, these are the two standard measurements you would make in a time-invariant network to test for reciprocity. Compute (using the same numerical techniques you have used in earlier assignments) $H_0(j2\pi f)$ and $\hat{H}_0(j2\pi f)$ over the range 0.8-1.2 Hz with a resolution of 0.01 Hz, and for $td = 0.3, 0.4, 0.5\,\text{s}$. Use K=256. For each td, plot on a separate figure the magnitude and phase of the voltage- and current-gains. What do you notice?