Homework 7

25. A signal $x(t)$ is described by

$$x(t) = \text{rect}(1000t) * \delta_{0.02}(t)$$

(a) If $x(t)$, is the input signal of an ideal lowpass filter with a cutoff frequency of 3 kHz, graph the input signal $x(t)$ and the output signal $y(t)$ on the same scale and compare.

(b) If $x(t)$, is the input signal of an ideal bandpass filter with a low cutoff frequency of 1 kHz and a high cutoff frequency of 5 kHz, graph the input signal $x(t)$ and the output signal $y(t)$ on the same scale and compare.

31. In figure E.31 are some descriptions of filters in the form of an impulse response, a frequency-response magnitude, and a circuit diagram. For each of these, to the extent possible, classify the filters as ideal or practical, causal or noncausal, lowpass, highpass, bandpass, or bandstop.

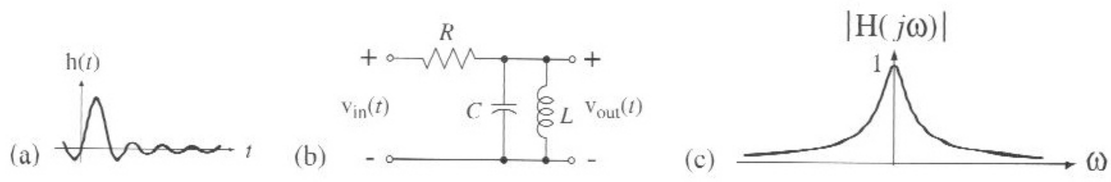

Figure E.31

40. When music is recorded on analog magnetic tape and later played back, a high-frequency noise component called tape "hiss" is added to the music. For purposes of analysis, assume that the spectrum of the music is flat at -30 dB across the audio spectrum from 20 Hz to 20 kHz. Also assume that the spectrum of the signal played back on the tape deck has an added component making the playback signal have a Bode diagram as illustrated in figure E.40.

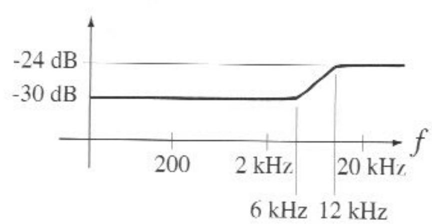

Figure E.40
Bode diagram of playback signal.

The extra high-frequency noise could be attenuated by a lowpass filter but that would also attenuate the high-frequency components of the music, reducing its fidelity. One solution to the problem is to "pre-emphasize" the high-frequency part of the music during the recording process so that when the lowpass filter is applied to the playback the net effect on the music is zero but the "hiss" has been attenuated. Design an active filter that could be used during the recording process to do the pre-emphasis.

42. In the system in figure E.42, $x_t(t) = \text{sinc}(t), f_c = 10$ and the cutoff frequency of the lowpass filter is 1 Hz. Graph the signals $x_t(t)$, $y_t(t)$, $y_d(t)$ and $y_f(t)$ and the magnitudes and phases of their CTFTs.

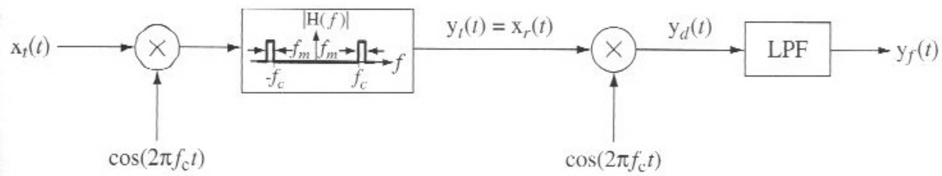

Figure E.42

47. A pulse train

$$p(t) = (1/w)\,\text{rect}(t/w) * \delta_{1/4}(t)$$

is modulated by a signal

$$x(t) = \text{sinc}(t)$$

Graph the output signal of the modulator $y(t)$ and the CTFTs of the input and output signals for

(a) $w = 10$ ms

(b) $w = 1$ ms