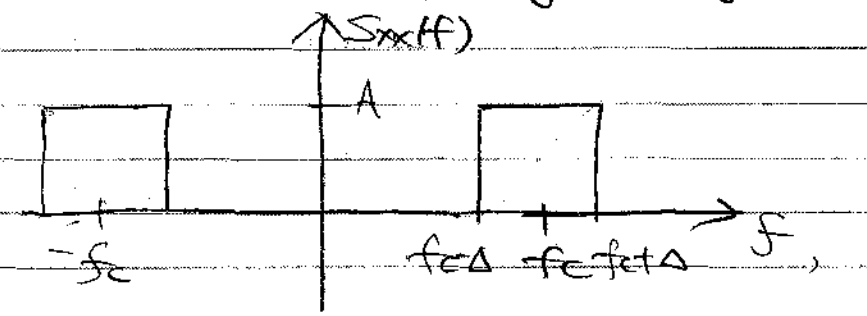
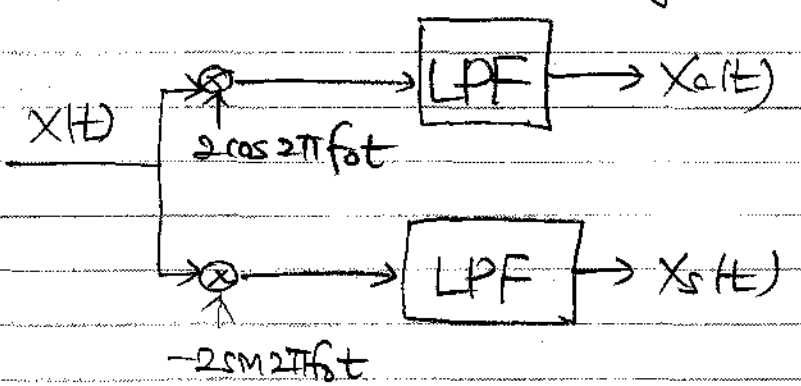
~~EECE 685F~~ Fall 05

HW #3

(15) 1. When $X(t)$ is a real-valued WSS random process with the PSD $S_{XX}(f)$ given by



and the I-Q demodulator is given by



answer the following questions

(5) (a) When $f_0 = f_c$, find $S_{X_cX_c}(f)$, $S_{X_sX_s}(f)$, and $S_{X_cX_s}(f)$

(b) When $f_0 = f_c + \frac{\Delta}{2}$, find $S_{X_cX_c}(f)$, $S_{X_sX_s}(f)$, and $S_{X_cX_s}(f)$

(10) (c) What is the necessary & sufficient condition for a real-valued WSS bandpass random process $Y(t)$ to have $S_{Y_cY_s}(f) = 0 \ \forall f$ at the output of an I-Q demodulator?

(10) 2. When $R = 10\Omega$ and $T = 273$ K, plot the PSD of a thermal noise. (Use MATLAB or C..)

(5) 3. Let $X(t)$ be a real-valued bandpass WSS r.p. w/

$$X_l(t) = X_c(t) + jX_s(t)$$

$$E[X_c(t)X_c(t+\tau)] = R_{X_cX_c}(\tau) \overset{FT}{\longleftrightarrow} S_{X_cX_c}(f)$$
$$E[X_c(t)X_s(t+\tau)] = R_{X_cX_s}(\tau) \overset{FT}{\longleftrightarrow} S_{X_cX_s}(f)$$

Find the PSDs and the cross PSD of $Y_c(t)$ & $Y_s(t)$ where

$$Y(t) = \mathrm{Re}\{Y_l(t)e^{j2\pi f_c t}\}$$

$$Y_l(t) = Y_c(t) + jY_s(t)$$

$$= X_l(t)e^{j\theta}$$

when θ is a constant. (This shows **the invariance of the PSDs and the cross PSD under phase shift**.)