~~EECE~~ 695f Fall 05

HW#2

(5) 1. Answer the following questions

(a) Show that any real-valued function $f(t)$ can be written as

$$f(t) = f_e(t) + f_o(t)$$

called **the odd part**

where $f_e(t) = f_e(-t)$ and $f_o(t) = -f_o(-t)$

the even part

(b) Show that any real-valued square matrix C can be written as

$$C = S + A$$

called **the anti-symmetric part.**

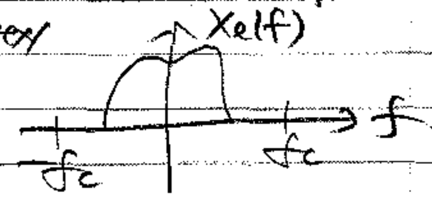
where $S = S^T$ and $A = -A^T$

called **the symmetric part**

(5) 2. Suppose that your receiver can coherently demodulate the signal. Discuss why in this case you prefer SSB (single-side band) modulation over DSD (double side band) for AM radio broadcasting?

(5) 3. Design a system that has a real bandpass signal $x(t) = \mathrm{Re}\{x_e(t)e^{j2\pi f_c t}\}$ as the input and the envelope $|x_e(t)|$ as the output. All your components must have real inputs & real outputs.

(5) 4 Answer the following questions.
Assume $x_e(t)$ & $h_e(t)$ are complex baseband signals with bandwidth less than f_c.



(a) Show that

$$\left(h_e(t)\,e^{j2\pi f_c t}\right) * \left(x_e(t)^*\, e^{-j2\pi f_c t}\right) = 0, \quad \forall t$$

(b) Show that

$$\left(h_e(t)\,e^{j2\pi f_c t}\right) * \left(x_e(t)\,e^{j2\pi f_c t}\right) = \left(h_e(t) * x_e(t)\right) e^{j2\pi f_c t}.$$

(5) 5 Answer the following questions.
Assume that $f(t)$ & $g(t)$ are real-valued baseband signals w/ bandwidth less than f_c.

(a) Show that

$$f(t)\cos(2\pi f_c t+\theta) = \mathrm{Re}\left\{\left(f(t)e^{j\theta}\right)e^{j2\pi f_c t}\right\}$$

(b) Show that

$$\int_{-\infty}^{\infty} f(t-\tau)\,g(\tau)\cos 2\pi f_c(t-2\tau)\,d\tau = 0 \quad \forall t.$$

(20) 6 The received signal is modeled as

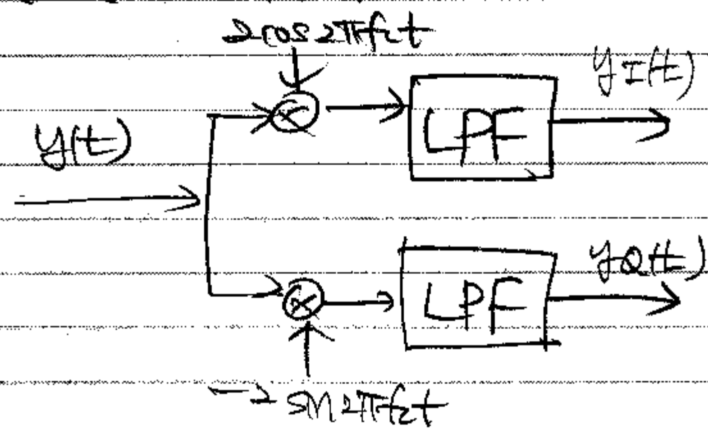
$$y(t) = \mathrm{Re}\{ y_\ell(t) e^{j2\pi f_c t} \}$$

where $y_\ell(t)$ is a complex baseband signal w/ bandwidth less than f_c

We want to correlated the complex envelope $y_\ell(t)$ with a complex signal $f_\ell(t) \triangleq f_I(t) + j f_Q(t)$

in the baseband, i.e., we want to design a system that down-converts $y(t)$ and then perform $\int_{-\infty}^{\infty} y_\ell(t) f_\ell^*(t) dt$.

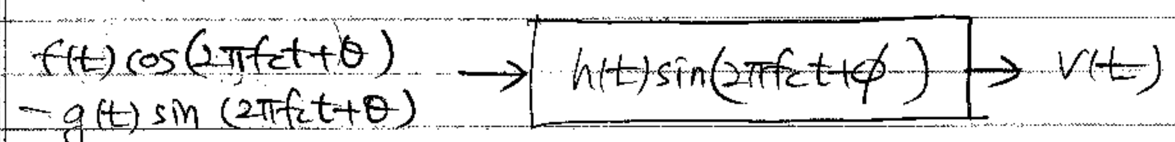
However, we are restricted to use real-input/real-output systems only and to use the I-Q demodulator.



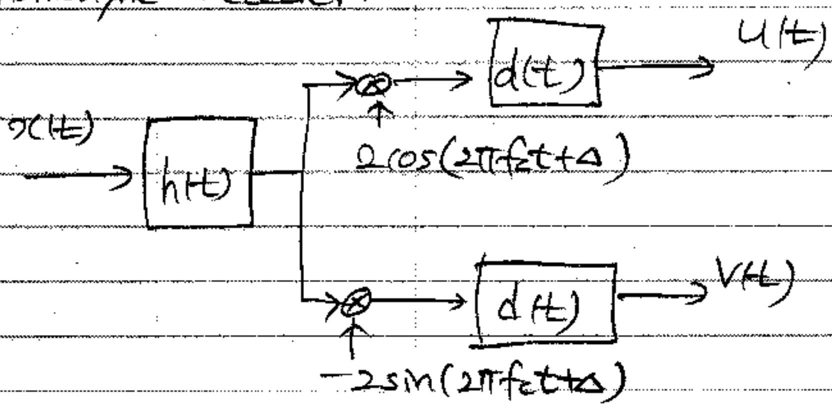
Draw a block diagram that processes $y_I(t)$ & $y_Q(t)$.

(5) 7. Suppose that $f(t)$, $g(t)$, and $h(t)$ are all real-valued baseband signals with bandwidth $< f_c$.

Find the output $V(t)$ of the following system.



(5) 8. Suppose that $a(t)$, $b(t)$, $c(t)$, and $d(t)$ are all real-valued baseband signals w/ bandwidth less than f_c. Find the output $u(t)$ & $v(t)$ of the following homodyne receiver.



where

$$x(t) = a(t)\cos(2\pi f_c t+\theta) - b(t)\sin(2\pi f_c t+\theta)$$

and

$$h(t) = 2c(t)\sin(2\pi f_c t-\phi)$$

(5) 9. Let $x(t)$ be a real-valued bandpass signal w/ energy E. Find the energy of the complex envelope $x_e(t)$