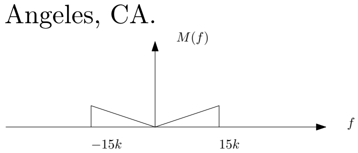
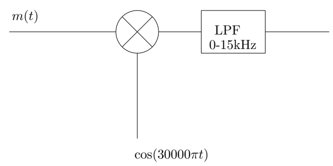
EE4440 HW#3

February 11, 2011

1. For what class of signals can a Fourier Series be computed?

2. The block diagram below is a very rudimentary scrambling system for analog communications. In ancient times it was used to secure the radio-telephone link from Santa Catalina Island, CA to Los Angeles, CA.



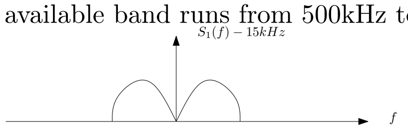


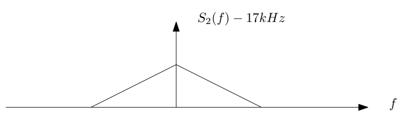
   (a) Draw a sketch of the spectrum of the system output, be careful to label all frequencies.

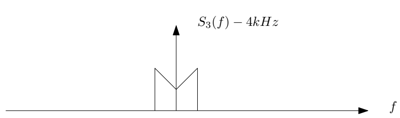
   (b) What is actually getting “scrambled here”?

   (c) If you were the LAPD police technician who was responsible for being able to tap this scrambled phone system what kind of system could you use? Produce a system block diagram along with spectral diagrams that prove your descrambler would work.

3. This May you are offered a job by Telemetry Systems ’R Us, Inc. The first week you are on the job your boss tells you that a current project requires a telemetry system that can transmit the three instrumentation signals shown below, and that you have 50kHz to transmit the data within. The available band runs from 500kHz to 550kHz.

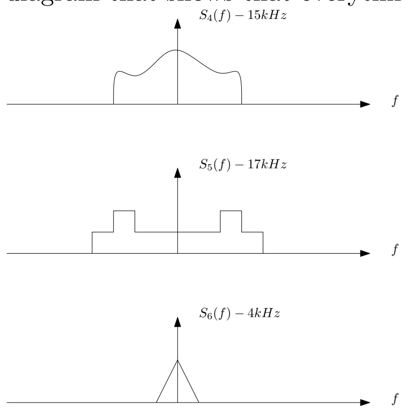






   (a) Choose appropriate carriers to transmit the instrumentation signals using DSB-SC draw a block diagram of the transmitter.

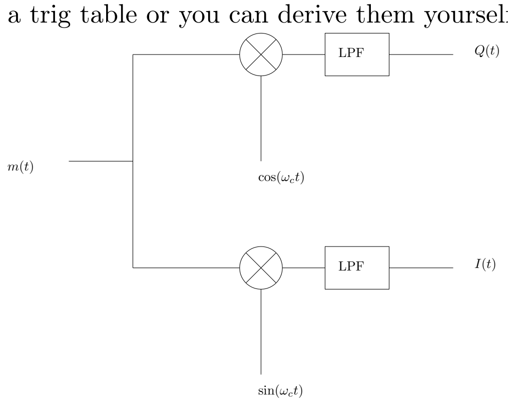
   (b) Your second week on the job, you new boss comes back to you and says, “oh, by the way, we now need to send twice as much data through the channel you were allocated.” The new signals are stereo channels of the original set, i.e. they have identical bandwidths 4,17 and 15 kHz. Luckily you know about SSB. Design an appropriate transmitter system complete with BPF specifications for each of the six channels, as well as carrier frequencies for each channel. Provide a spectral diagram that shows that everything will fit.



(c) Design a receiver system that can recover the transmitted signal from part b, include a block diagram.

(d) Look in your book and identify another method of generating and demodulating SSB signals. Include a block diagram for this system.

4. In class we derived the output for a quadrature receiver using the expression $x(t) = a(t)\sin(\omega_c t + \phi(t))$. Verify that the output is identical if we instead use the expression $x(t) = I(t)\sin(\omega_c t) + Q(t)\cos(\omega_c t)$. (You will find the product-to-sum trig identities very helpful for this exercise, you can get them from a trig table or you can derive them yourself from Euler's identities.)



5. For the case of a QAM system such as the one described on page 205 of your text, what are $I(t)$ and $Q(t)$? QAM is widely applied in consumer, industrial, and military systems. Find a system that uses QAM and cite your source.

6. Use the Interwebs to find the data sheet for a mixer and answer the following:

(a) What physical interface does the mixer use (SMA, BNC, DIP, SMT, etc.) ?

(b) What is the RF range? What does the RF input do?

(c) What is the IF range? What does the IF input do? What does IF stand for?

(d) What is the LO range? What does LO stand for?

(e) What is the cost of the mixer you have found?

(f) What mixer configuration or topology does the mixer you found use?

(g) Can your mixer be used in the broadcast AM frequency range?

(h) Can it be used in the FM frequency range?

(i) Can it be used in the 802.11 WiFi frequency range?

(j) Circle the parts of the data sheet you used to come to your conclusions.

7. For the DSB-SC system we discussed in class please analyze the effect on $m'(t)$ of:

   (a) A phase error in the receiver's oscillator, i.e. instead of generating $\cos(\omega_c t)$ it generates $\cos(\omega_c t+\theta)$.

   (b) A small frequency error in the receiver's oscillator, i.e. instead of generating $\cos(\omega_c t)$ it generates $\cos((\omega_c + \Delta\omega)t)$.

8. Show that a DSB-SC receiver can receive AM. What additional block will be required at the receiver output to allow recovery of $m(t)$ without an offset?