EE 567
Homework 12

Problem 1 (from Sklar, Digital Communications, 2nd ed.). Assume that a repeat-back jammer is located $d = 30$ km away from the communicator. Assume further that the jammer can monitor any uplink transmission from the communicator to a nearby satellite. How fast must the communicator hop his frequency to evade the repeat-back jammer? Assume that the jammer can change its jamming frequnecy in zero time and that the only differential delay between the communicator's uplink signal and the jamming uplink signal is the propogation delay from the communicator to the jammer.

Solution: To evade the repeat-back jammer the communicator must ensure the transmission time at a particular frequency and the jammer's attempt to disrupt that transmission using that frequency do not overlap in time. Thus, the duration of each hop (how long the communicator dwells at a particular frequency) must satisfy

$$T_{\text{hop}} \leq \frac{d}{c} = \frac{3 \times 10^4 \text{ m}}{3 \times 10^8 \text{ m/sec}} = 10^{-4} \text{ sec}$$

Problem 2. Short answers (no derivations needed).

a. List one advantage of digital communications over analog communications.

Solution: Allow for the use of error correction coding.

b. What advantage do we gain in transmitting communication signals at high frequencies instead of low frequencies?

Solution: We can use a smaller antenna to achieve the same gain as a larger antenna at a lower frequency.

c. What are the two primary kinds of error that lead to pointing losses by an antenna?

Solution: Knowing where the receiver is actually located and being able to physically point where desired.

d. In cascading filters in a receiver do you want to place most of the gain in the first filter or the last filter in the cascaded chain (or does it

matter)? Why?

Solution: We want most of the gain in the first stage because in the noise figure equation for a cascaded system the gain in the first stage appears in the denominator of all subsequent terms in equation so it has the most influence in limiting noise effects later in the processing.

e. Write down the formula for probability of bit error for BPSK modulation in AWGN.

Solution: $P_b = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$.

f. When using a frequency hopping spread spectrum system why would you not want to dwell very long at a particular frequency before hopping to another frequency?
Solution: We do not want to dwell at a particular frequency very long since doing so might allow a jammer to locate our signal in the spectrum and jam us more directly by concentrating jammer energy in our signal bandwidth.