Problems for Week 1: Review of Fundamentals

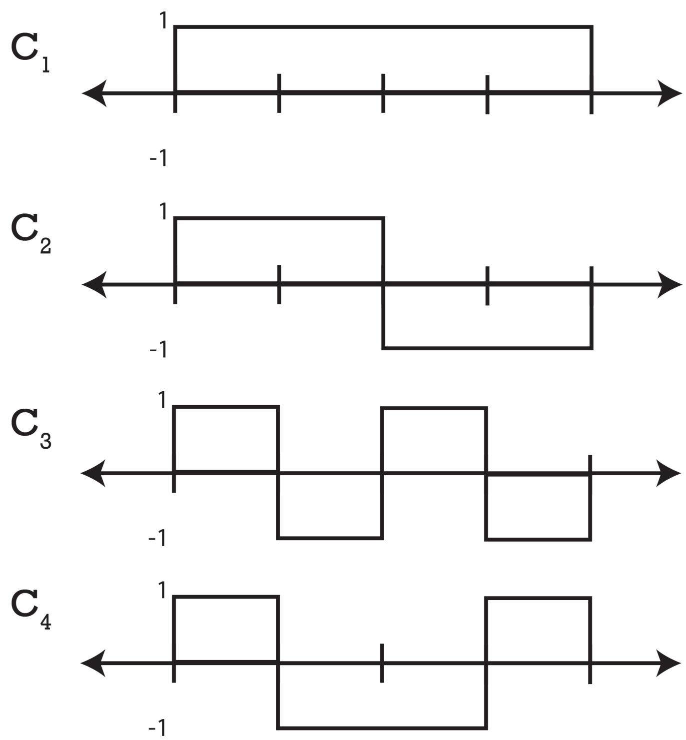
1) Assume that a DC3 has a typical survey velocity of 90 m/s and a typical survey height of 500 m above the ice surface. If the aircraft is carrying a radar sounder with a center frequency of 60 MHz:
   a. What is the Doppler frequency a radar return from the surface directly below the aircraft?
   b. What is the Doppler frequency of a radar return from a point on the ice surface 500 m ahead of the aircraft?
   c. What is the Doppler frequency of a radar return from a point on the ice surface 500 m behind the aircraft?
   d. What is the maximum possible Doppler frequency of a radar return from any point on the ice surface?

2) Assume the relative permittivity of glacial ice is 3.2,the relative permittivity of free space is 1/36π x 10-9 F/m, and the permeability of free space, as well as glacial ice, is 4π X 10-7 H/m.
   a. How far will a radar pulse travel in1 μs in air?
   b. How far will a radar pulse travel in1 μs in glacial ice?

3) Assume that glacial ice has a relative permittivity of 3.2, marine ice has are relative permittivity of 3.4 and seawater has a relative permittivity of 77. How many times stronger would a radar reflection from the bottom of an ice shelf (glacial ice exposed to seawater) be than a reflection from a glacial ice to marine ice transition?

4) Assume that you make a measurement of some value in the presence of known Gaussian noise (with a mean value of A and a standard deviation of B). What is the probability that a measured value of C or larger would be produced by the known noise source if:
   a. A = 1, B = 1, C = 1 ?
   b. A = 1, B = 1, C = 2 ?
   c. A = 0.5, B = 1, C = 1 ?
   d. A = 1, B = 0.5, C = 1 ?
   e. In light of these probabilities, if you wanted to a signal in the presence of noise, what are three changes to the signal and/or noise that would increase the chance that you would measure signal instead of noise?

5) GPS receivers identify different satellites using a set of orthogonal codes and convolution in a scheme called Code Division Multiple Access (CDMA). Below are four different orthogonally coded functions (C1, C2, C3, C4).



a. What is C1 * C1 ?
b. What is C1 * C2 ?
c. What is C3 * C4 ?
d. What is C4 * C4 ?
e. Why are these codes considered orthogonal?