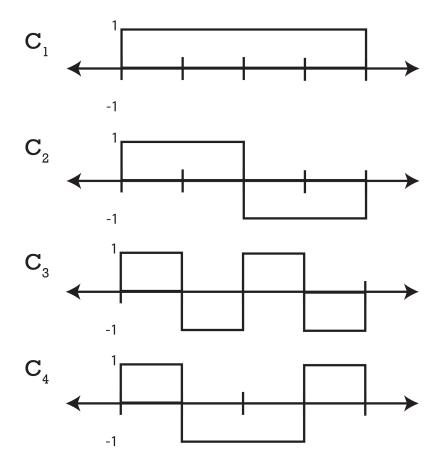
Problems for Week 1: Review of Fundamentals

- 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 $1/36\pi \times 10^{-9}$ F/m, and the permeability of free space, as well as glacial ice, is $4\pi \times 10^{-7}$ H/m.
 - a. How far will a radar pulse travel in $1 \mu s$ in air?
 - b. How far will a radar pulse travel in $1 \mu s$ 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 $C_1 * C_1$?
- b. What is $C_1 * C_2$?
- c. What is $C_3 * C_4$?
- d. What is $C_4 * C_4$?
- e. Why are these codes considered orthogonal?