Show that **cos (2π*f*n) = cos (2π (*f* + 1) n)**, which means that a sinusoid having a frequency larger than one corresponds to a sinusoid having a frequency less than one.

**Exercise 1.4.1**

**Note:** Notice that we shall call either sinusoid an analog signal. Only when the discrete-time signal takes on a finite set of values can it be considered a digital signal.

Can you think of a simple signal that has a finite number of values but is defined in continuous time? Such a signal is also an analog signal.

**Exercise 1.4.2**

#### Communicating Information with Signals

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The basic idea of communication engineering is to use a signal's parameters to represent either real numbers or other signals. The technical term is to **modulate** the **carrier** signal's parameters to transmit information from one place to another. To explore the notion of modulation, we can send a real number (today's temperature, for example) by changing a sinusoid's amplitude accordingly. If we wanted to send the daily temperature, we would keep the frequency constant (so the receiver would know what to expect) and change the amplitude at midnight. We could relate temperature to amplitude by the formula ***A*** *=* ***A0****(1 + k****T****)*, where ***A0*** and ***k*** are constants that the transmitter and receiver must both know.

If we had two numbers we wanted to send at the same time, we could modulate the sinusoid's frequency as well as its amplitude. This modulation scheme assumes we can estimate the sinusoid's amplitude and frequency; we shall learn that this is indeed possible.

Now suppose we have a sequence of parameters to send. We have exploited all of the sinusoid's two parameters. What we can do is modulate them for a limited time (say ***T*** seconds), and send two parameters every ***T***. This simple notion corresponds to how a modem works. Here, typed characters are encoded into eight bits, and the individual bits are encoded into a sinusoid's amplitude and frequency. We'll learn how this is done in subsequent modules, and more importantly, we'll learn what the limits are on such digital communication schemes.