Homework Assignment 9: Due at the beginning of class 10/12/01

A function *h* is defined by the graph shown in Figure 1 below. Questions 1 and 2 refer to this function.
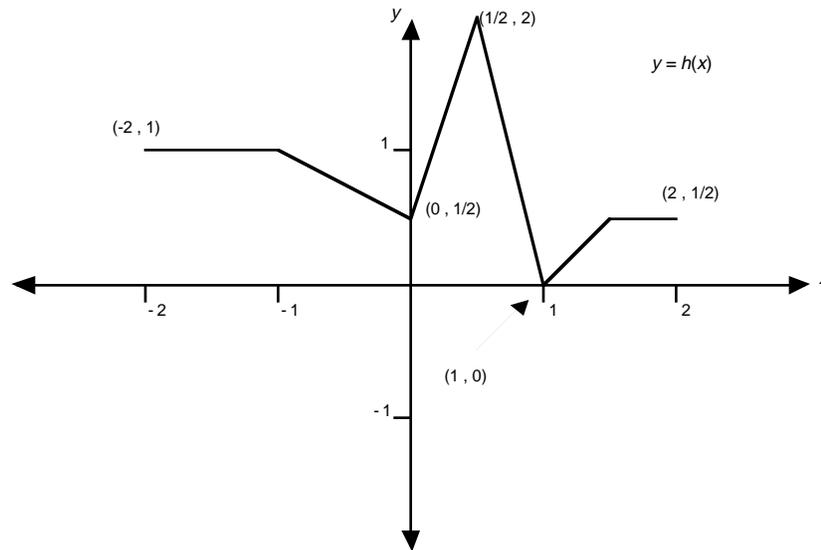

Figure 1: Graph of $y = h(x)$ for Questions 1 and 2.

1.   A new function, *p* is defined by the equation:

$$p(x) = -h(x + 1) + 2.$$

Describe how $p(x)$ can be obtained from the function $h(x)$ using a series of geometrical transformations. (You should be careful to describe both the transformations that must be performed as well as the order that they should be performed in.)

2.   Sketch an accurate graph of $y = p(x)$ labeling all of the points that lie at the end of a line segment.

Figure 2[1] shows the readout from an electrocardiogram (ECG) machine. The signal shown in Figure 2 depicts the normal heart function of an individual at rest. The horizontal direction represents time, with each small square representing 0.04 seconds. The vertical axis represents electrical activity, with each small square representing a voltage of 0.1 mV.
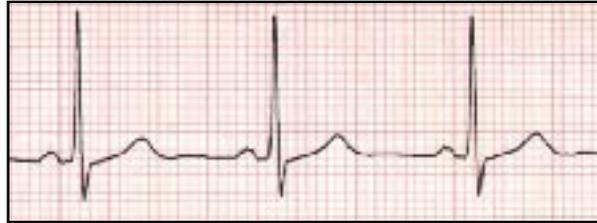

Figure 2: Output from an ECG machine showing a normal heart beat (sinus rhythm).

Questions 3, 4 and 5 refer to Figure 2.

3. Use the graph shown in Figure 2 to calculate the length (in seconds) of each heart beat. (One complete heart beat consists of a complete set of pulses together with one of the long, flat portions of the graph.) How many times does this person's heart beat each minute?

4. The ECG output shown in Figure 2 was from a 31 year old, healthy male. Let the function B be the function graphed in Figure 2. That is, Figure 2 shows the graph of $y = B(t)$. According to some physiological models[2], the maximum heart rate for a healthy 31 year old male is 189 beats per minute. Modify the function B to create a new function that will represent the ECG trace when the person's heart is beating at the maximum possible rate. (Note: you do **not** have to find an explicit equation for $B(t)$.)

5. Each individual heartbeat includes an upward and a downward "spike." In cardiology, the large upward spike is called the "R" wave and the smaller downward spike is called the "S" wave. Working from Figure 2, determine the difference in voltage between the top of the "R" wave and the bottom of the "S" wave. How could you modify the function B so that it would describe the ECG of a patient with a 30 mV difference between the "R" and "S" waves? (Note: you do **not** have to find an explicit equation for $B(t)$.)