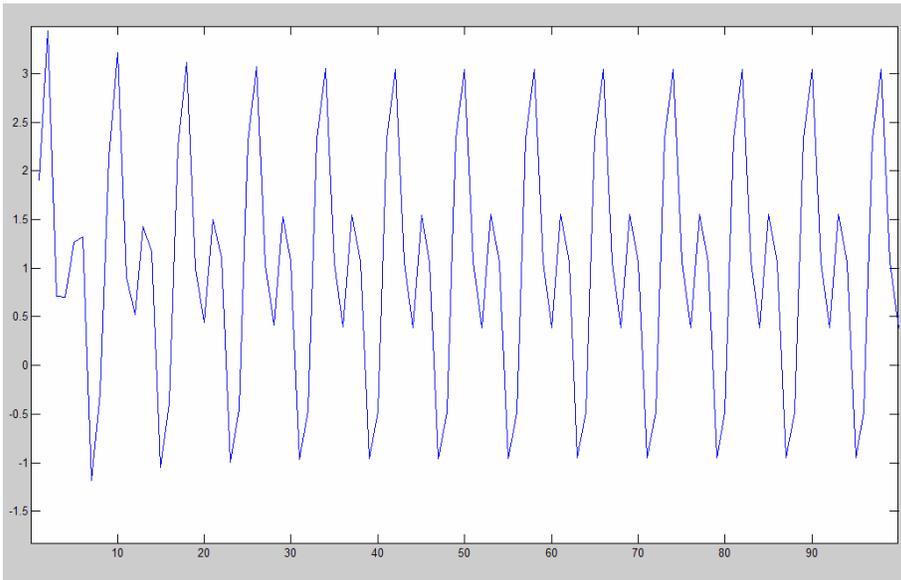
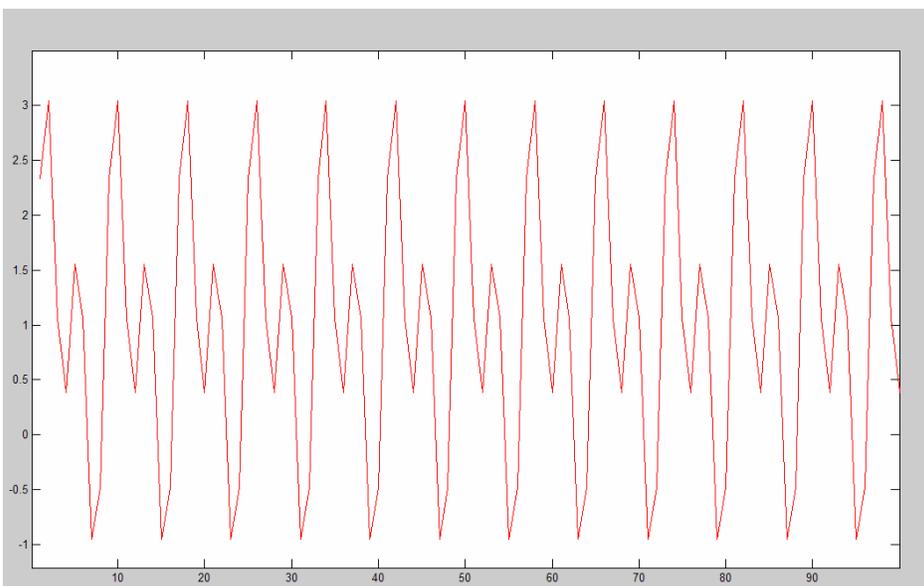


## Matlab code and graphs of the equations generated from the code:

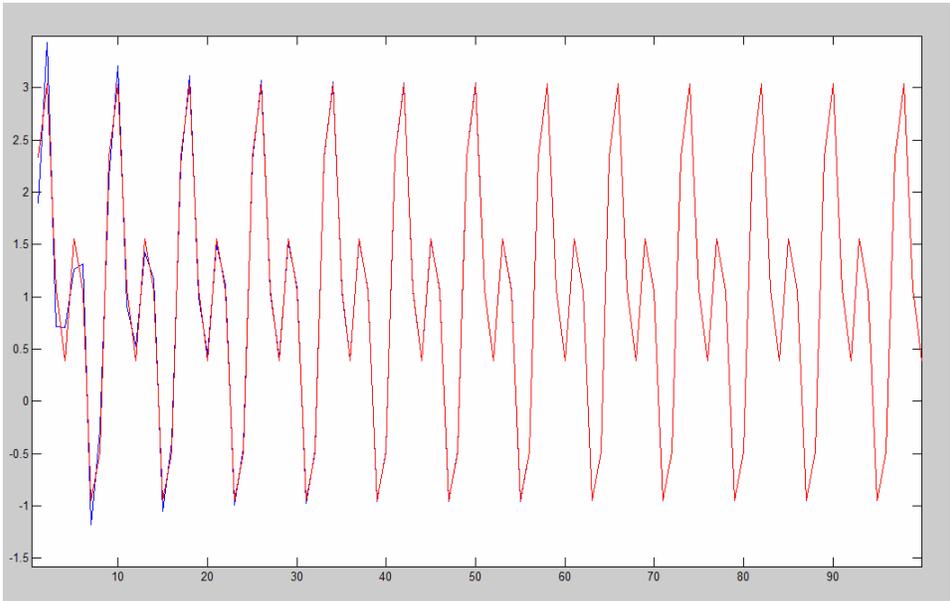
```
syms x y h n a b
n = (0:1:100);
a = pi/4;
b = pi/2;
x = 1 + sin(a*n) + sin(b*n);
h = (1.9*(-0.9).^n);
y = conv(x,h)
a = 1+1.08*sin(a*n+.371)+1.41*sin(b*n+.733);
plot(y, 'b')
hold
plot(a, 'r')
```



Plot of the convolution of x and h.



Plot of the response to the sinusoidal input.



Plot of both equations simultaneously to show that they are the same.

### Details of how the answer was reached:

In order to solve part c of the problem, the response  $y[n]$  can be found by using the equations and procedures detailed on page 250 of the textbook in section 5.5.1. In this section, the procedure for finding the response  $y[n]$  for a sinusoidal input is reduced down into the formula 5.65 on page 250. The formula is as follows:

$$y[n] = A |H(\Omega_0)| \cos(\Omega_0 n + \theta + \angle H(\Omega_0)), \nu = 0, \pm 1, \pm 2, \pm 3, \dots$$

And for the case of this problem, the solution to homework problem 5.4 was consulted and the specific equation to be used was determined to be as follows:

$$y[n] = 1 |H(0)| + |H(\frac{\pi}{4})| \sin(\frac{\pi}{4}n + \angle H(\frac{\pi}{4})) + |H(\frac{\pi}{2})| \sin(\frac{\pi}{2}n + \angle H(\frac{\pi}{2}))$$

The equation used in the Matlab portion of this solution was found analytically and the work to find this response is attached in this submission. Since the input of the example is a cosine function, the equation above has a cosine in its result. Since the input of the problem assigned is a sine, the result is a function of sine as well.

Since the equation used to find the output response  $y[n]$  is given by:

$$y[n] = h[n] * x[n]$$

Matlab can be used to find this output response easily using the 'conv' function built into the program. Combining this equation with the output response found earlier and plotting them together in Matlab shows that the two equations are the same.

Analytical:

5.45 (c)  $h[n] = 1.9 (-0.9)^n u[n]$

compute  $y[n]$  for an input of  $x[n] = 1 + \sin(\frac{\pi}{4}n) + \sin(\frac{\pi}{2}n)$

Using the guidance shown on page 250 of the textbook for a sinusoidal input, the output will be a sinusoid in the form of:

$$y[n] = |H(0)| + |H(\frac{\pi}{4})| \sin(\frac{\pi}{4}n + \angle H(\frac{\pi}{4})) + |H(\frac{\pi}{2})| \sin(\frac{\pi}{2}n + \angle H(\frac{\pi}{2}))$$

Find  $H(z)$  to compute coefficients:

$$h[n] \leftrightarrow H(z) = \frac{1.9}{1 + 0.9z^{-1}} = \frac{1.9e^{j\omega}}{e^{j\omega} + 0.9}$$

First, find  $H(0) = \frac{1.9}{1 + 0.9e^0} = \frac{1.9}{1.9} = 1 \angle 0^\circ \rightarrow |H(0)| = 1$

Next, find  $H(\frac{\pi}{4}) = \frac{1.9 e^{j\pi/4}}{e^{j\pi/4} + 0.9} = \frac{1.9(\cos \frac{\pi}{4} + j \sin \frac{\pi}{4})}{\cos \frac{\pi}{4} + j \sin \frac{\pi}{4} + 0.9} = \frac{1.34 + j1.34}{1.607 + j1.707}$   
 $= \frac{1.9 \angle 45^\circ}{1.76 \angle 23.75^\circ} = 1.08 \angle 21.27^\circ = 1.08 \angle 0.371 \text{ rad}$

Lastly, find  $H(\frac{\pi}{2}) = \frac{1.9 e^{j\pi/2}}{e^{j\pi/2} + 0.9} = \frac{1.9(\cos \frac{\pi}{2} + j \sin \frac{\pi}{2})}{\cos \frac{\pi}{2} + j \sin \frac{\pi}{2} + 0.9} = \frac{1.9(0 + j)}{0.9 + j}$   
 $= \frac{1.9j}{0.9 + j} = \frac{1.9 \angle 90^\circ}{1.35 \angle 48^\circ} = 1.41 \angle 42^\circ = 1.41 \angle 0.733 \text{ rad}$

This yields a final result of:

$$y[n] = 1 + 1.08 \left( \frac{\pi}{4}n + 0.371 \right) + 1.41 \sin \left( \frac{\pi}{2}n + 0.733 \right)$$