PROBLEM 1.1:
(3 points) Consider 256 × 256 color images where each pixel value is represented using 24 bits.

(a) (1 point) For a slide show, each image needs to be processed within 1 second. Using the DSP56858, what is the maximum number of instructions that can be used for processing an image within 1 second?

(b) (1.5 points) For real-time video transmission or playback, a rate of 30 frames (images) per second is used. Using the DSP56858, what is the maximum number of instructions that can be used to process a video frame?

(c) (1.5 points) For real-time color video at 30 frames (images) per second, how many memory locations are needed to store 0.5 second of video using the DSP56858? (Hint: each memory location is 16 bits)?

PROBLEM 1.2:
(4 points) Consider a system $S$ with the following input-output relationship:

$$y(n) = \frac{1}{6}x(2n) - \frac{1}{3}x(n + 1) - \frac{1}{4}x(n - 3)$$

(a) (1 point) Determine if the system $S$ is linear. Show your work and justify your answer to receive credit.

(b) (1 point) Determine if the system $S$ is shift-invariant. Show your work and justify your answer to receive credit.

(c) (1 point) Determine and plot the impulse response of the system.

(d) (1 point) Consider the following input:

\[
x(n) = \begin{cases} 
0.75, & n = 0 \\
0.5, & n = 2 \\
0.25, & n = 3 \\
0, & \text{otherwise}
\end{cases}
\]

Compute the output of the system at $n = 1$, $y(1)$. 

**PROBLEM 1.3:**
(3 points) Consider an analog sinusoidal signal \( x(t) \) given by:

\[
x(t) = 4 \sin (4000\pi t + \pi/3)
\]

(a) Determine the frequency in Hertz of the analog sinusoid \( x(t) \).

(b) Determine the discrete-domain signal \( x(n) \) that is obtained by sampling \( x(t) \) with a sampling frequency \( f_s = 6000 \) Hertz.

(c) For \( x(n) \) obtained as in (b), determine the number of instructions that can be performed during the sampling interval (time between two consecutive samples) using the DSP56858 running at 120 MIPS.

**PROBLEM 1.4:**
(2 points) Consider a system with the following input-output relation:

\[
y(n) = 2x(n - 1) + x(n)
\]

(a) Determine the impulse response of this system.

(b) Is this system FIR or IIR? Justify your answer.

**PROBLEM 1.5:**
(5 points) Consider the following two signals:

\[
x(n) = \begin{cases} 
1, & n = 0, 1, 2, 3 \\
0, & \text{otherwise}
\end{cases}
\]

and

\[
h(n) = \begin{cases} 
1, & n = 0, 1, 2 \\
0, & \text{otherwise}
\end{cases}
\]

(a) Compute and plot the convolution \( x(n) \ast h(n) \).

(b) Compute and plot the 4-point circular convolution of \( x(n) \) with \( h(n) \) and compare the result to the linear convolution result in (a).

(c) Determine the minimum size of the circular convolution so that it gives the same result as the linear convolution.

(d) Using the size determined in (c), compute and plot the circular convolution.