1. An LTI system is characterized by the following input-output relationship:

\[ y(t) = \int_{-\infty}^{t-1} (\tau - t)x(\tau) d\tau. \]  

(a) Determine the impulse response \( h(t) \) of the system. (7 pts)

(b) Is \( h(t) \) BIBO stable? Causal? Justify your answers. (8 pts)
2. Let $h(t) = u(t)$ and $x(t) = t[u(t) - u(t - 1)]$

(a) Plot $h(t)$ and $x(t)$, and carefully label the values on the axes. (5 pts)

(b) Determine $y(t) = x(t) \ast h(t)$ by performing **graphical convolution**. Hint: It is easier if you flip $h(t)$. No need to sketch $y(t)$. (20 pts)
3. An LTI system consists of three LTI subsystems $h_1(t)$, $h_2(t)$, and $h_3(t)$ as shown below:

Figure 1: Problem 3.

$h_1(t)$ has the frequency response:

$$H_1(j\omega) = \begin{cases} \omega & -\pi \leq \omega \leq \pi, \\ 0 & \text{otherwise,} \end{cases}$$

$h_2(t)$ has the frequency response:

$$H_2(j\omega) = \begin{cases} -\omega & -\frac{\pi}{4} \leq \omega \leq 2\pi, \\ 0 & \text{otherwise}, \end{cases}$$

and $h_3(t)$ has the frequency response:

$$H_3(j\omega) = \begin{cases} 1 & -\frac{\pi}{3} < \omega \leq \frac{\pi}{3}, \\ 0 & \text{otherwise}, \end{cases}$$

Let $x(t) = 2 + \cos\left(\frac{\pi}{6}t\right) + \sin\left(\frac{\pi}{2}t\right)$.

(a) Plot $H_1(j\omega)$, $H_2(j\omega)$, and $H_3(j\omega)$ on three separate graphs. (5pts)

(b) Determine $y(t)$, $z(t)$, $v(t)$, $w(t)$. (20pts)
4. (20 pts) Compute the appropriate Fourier representation of the following signals:

(a) 
\[ x[n] = 2 \sin \left( \frac{3\pi}{4} n \right) + \cos \left( \frac{2\pi}{3} n \right) \] \hspace{1cm} (2)

(b) 
\[ x(t) = \sum_{n=0}^{100} 2^{-t} \delta(t - 3n) \] \hspace{1cm} (3)
5. (15pts) Let

\[ x(t) = \frac{d(e^{-|t-3|})}{dt} * u\left(\frac{t}{3}\right) \xrightarrow{\text{FT}} X(j\omega), \]  

use the properties of FT and the well-known FT pairs to find \( X(j\omega) \).
6. **Bonus Question: (10pts)**

   (a) True or False: If $x(t) \overset{FT}{\leftrightarrow} X(j\omega)$, then $x(-t) \overset{FT}{\leftrightarrow} X(-j\omega)$. Justify your answer.