Last Name: First Name:

HW04

1. Two signals, $x_1(t)$ and $x_2(t)$, are defined as follows,

$$x_1(t)=\begin{cases}1 & -1\le t\le 0\\ 2 & 0\le t\le 1\\ 0 & \text{elsewhere}\end{cases},\qquad x_2(t)=\begin{cases}2 & -2\le t\le 1\\ 1 & 1\le t\le 2\\ 0 & \text{elsewhere}\end{cases}$$

and are shown in Figure 1. Perform the convolution $y(t)=x_1(t)*x_2(t)$. Plot the result $y(t)$ in the time domain and, using MATLAB, in the frequency domain ($\mathcal{F}\{y(t)\}$) (both magnitude & phase plots).

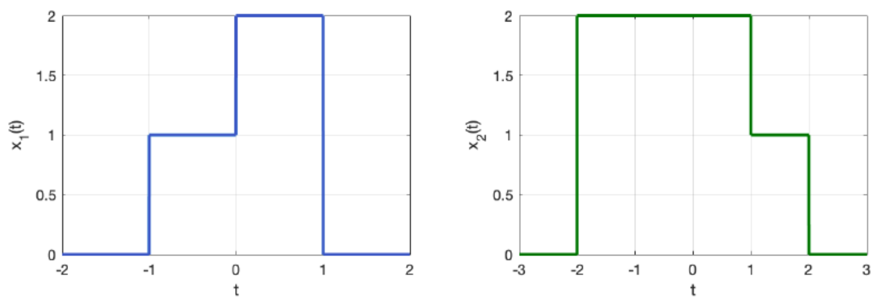


Figure 1: $x_1(t)$ and $x_2(t)$ for Problem 1.

2. Two signals, $x_3(t)$ and $x_4(t)$, are defined as follows,

$$x_3(t)=\begin{cases}t^2 & -2\le t\le 0\\ 0 & \text{elsewhere}\end{cases},\qquad x_4(t)=\begin{cases}-3t+15 & 4\le t\le 5\\ 0 & \text{elsewhere}\end{cases}$$

and are shown in Figure 2. Perform the convolution $x_3(t)*x_4(t)$ and plot the result in the time domain only.

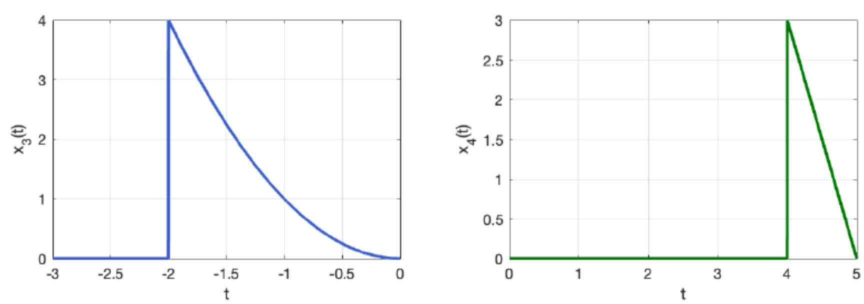
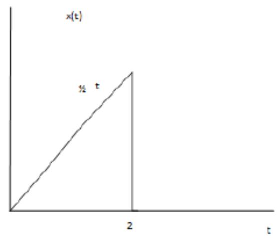
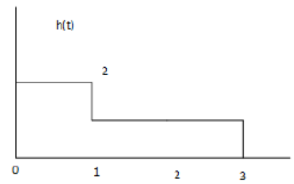


Figure 2: $x_3(t)$ and $x_4(t)$ for Problem 2.





3. If a function is given as

$$y(t) = 3\Delta\left(\frac{t-5}{4}\right)$$

Note: As you may know that $\left[3\Delta\left(\frac{t-5}{4}\right)\right]$ *means just like the rect function. Amplitude: 3, centered at: 5, width: 4*

Find a function $h(t)$ and plot it so the following equation holds

a) $y(t) = 1 \cdot \Pi\left(\frac{t-1}{2}\right) * h(t)$

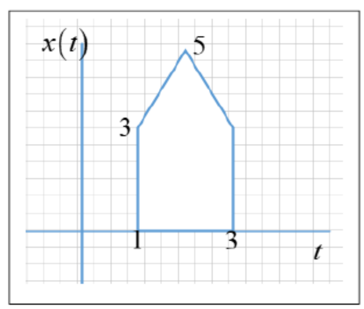
b) $y(t) = 2 \cdot \Pi\left(\frac{t-7}{2}\right) * h(t)$

c) $y(t) = -1 \cdot \Pi\left(\frac{t+5}{2}\right) * h(t)$

4. Find convolution of two functions

$$y(t) = 1 \cdot \Pi\left(\frac{t-1}{2}\right) * \left[2 \cdot \Pi\left(\frac{t-2}{2}\right) + 2 \cdot \Pi(t-5) + 2 \cdot \delta(t-7)\right]$$

Yes there is no mistake; you see a Dirac delta function on the right functions



a) Find $y(t)$

b) Plot $y(t)$

c) Find frequency response of $y(t)$

d) Plot magnitude and phase of part (c)

5 In class, we proved that convolution in the time domain corresponds to multiplication in the frequency domain. That is,

$$\mathrm{F}\left\{x(t)*h(t)\right\} = F\left\{\int_{\tau=-\infty}^{\infty} x(\tau)\cdot h(t-\tau)\,d\tau\right\} = X(f)H(f)$$

where $\mathcal{F}\left\{x(t)\right\} = X(f)$ denotes the Fourier transform of $x(t)$. **Now show** that convolution in the frequency domain corresponds to multiplication in the time domain:

$$\mathcal{F}^{-1}\left\{X(f)*H(f)\right\} = x(t)h(t)$$

where $\mathcal{F}^{-1}\left\{X(f)\right\}$ denotes the inverse Fourier transform of $X(f)$.

6 Convolution

a. $x(t)$ is shown in Figure 1. Perform the convolution $y(t) = x(t) * x(t)$; that is, $x(t)$ convolved with itself. And plot $Y(f)$ in magnitude and phase where $[-10 \le f \le 10]$

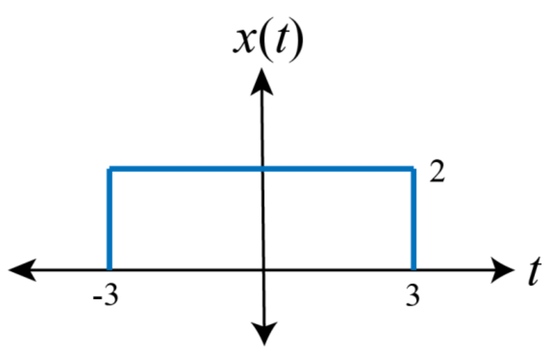


Figure 1: x(t) for problem 2(a).

b. $x_1(t)$ and $x_2(t)$ are shown in Figure 2. Perform the convolution $y(t) = x_1(t) * x_2(t)$. And plot $Y(f)$ in magnitude and phase where $[-10 \le f \le 10]$

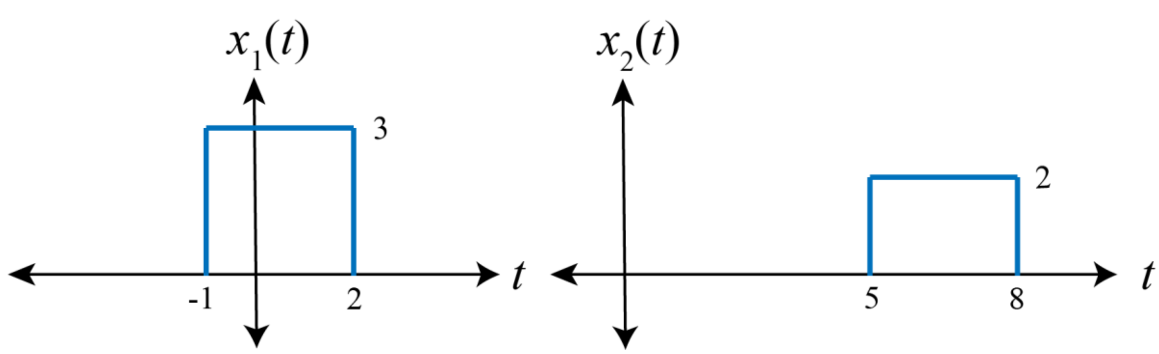


Figure 2: $x_1(t)$ and $x_2(t)$ for problem 2(b).

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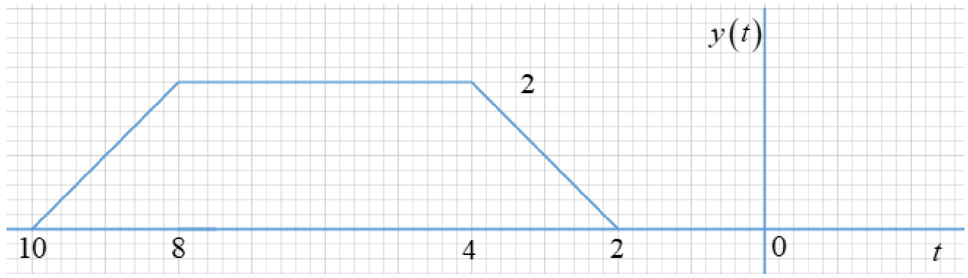
7 Output of a filter, $y(t)$, is shown below.



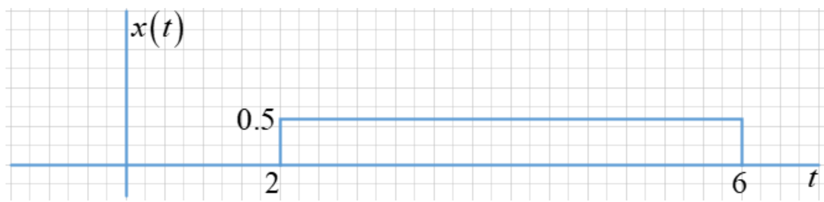
If input, $x(t)$, is given as shown below,

$$y(t) = x(t) * h(t)$$

a) Find $h(t)$ and plot it.

b) Find $Y(f)$ based on $F\{x(t)\}$ & $F\{h(t)\}$

c) Plot magnitude and phase of $Y(f)$ using tools. $[-10 \le f \le 10]$



If filter, $h(t)$, is given as shown below,

$$y(t) = x(t) * h(t)$$

d) Find $x(t)$ and plot it.

e) Find $Y(f)$ based on $x(t)$ & $h(t)$

f) Plot magnitude and phase of $Y(f)$ using tools $[-10 \le f \le 10]$