2016 Fall - Introduction to Communication Systems

Homework 1 (Due to Oct.10)

Part 1: Textbook Exercise

1. Plot the following signals:
   - $x_1(t) = \prod(2t+5)$
   - $x_2(t) = sinc(10t)$
2. We have seen that $x(t) \star \delta(t) = x(t)$. Show that
   - $x(t) \star \delta^n(t) = \frac{d^n}{dt^n} x(t)$
   - $x(t) \star u_{-1}(t) = \int_{-\infty}^{t} x(\tau) d\tau$
3. Determine whether the following systems are time variant or time invariant:
   - $y(t) = (t+2)x(t)$
   - $y(t) = \int_{-\infty}^{t} x(\tau) d\tau$
4. Determine the Fourier-series expansion of the following signal:
   - $x_1(t) = \sum_{n=-\infty}^{\infty} \Lambda(t-2n)$
   - $x_2(t) = \cos(t) + (cos 2.5t)$
5. Determine the Fourier transform of each of the following signals:
   - $x_1(t) = \frac{1}{1+t^2}$
   - $x_2(t) = tsinc(t)$

Part 2: Matlab Exercise : Fourier series

The periodic signal $x(t)$, with period T_0, is defined as

$$x(t) = A\Pi\left(\frac{t}{2t_0}\right) = \begin{cases} A, |t| \le t_0 \\ 0, otherwise \end{cases}$$

for $|t| \le \frac{T_0}{2}$, where $t_0 < \frac{T_0}{2}$. Let A=2, T_0=4, t_0=1. (same figure 2.25, the difference is that $2t_0 = \tau$)

- Demonstrate mathematically that the Fourier-series coefficients in the expansion of $x(t)$ are given as $x_n = \frac{1}{2} sinc(\frac{n}{2})$.
- Use Matlab to plot the original signal $x(t)$ and the Fourier-series approximation of $x(t)$ over one period for n = 1, 5, 9, 13, ..., 73. Note that as n increases, the approximation becomes closer to the original signal $x(t)$.