A Comment on Frequency, Bandwidth, and Fourier Transforms

Spring 2016

In this course, we use Fourier transforms with respect to the frequency variable f (measured in Hertz) rather than the radian frequency variable $\omega = 2\pi f$ (radians per second) that you used in ECE 210. Thus,

$$\begin{aligned} X(f) &= \int_{-\infty}^{\infty} x(t) \exp(-j2\pi f t)\, dt, \\ x(t) &= \int_{-\infty}^{\infty} X(f) \exp(j2\pi f t)\, df, \text{ and} \\ \int_{-\infty}^{\infty} |x(t)|^2\, dt &= \int_{-\infty}^{\infty} |X(f)|^2\, df. \end{aligned}$$

Note also that the unit rectangular pulse $\text{rect}(\cdot)$ and the sinc function $\text{sinc}(\cdot)$ are defined as

$$\begin{aligned} \text{rect}(t) &= \begin{cases} 1, & |t| < \frac{1}{2}, \\ 0, & |t| > \frac{1}{2}, \end{cases} \text{ and} \\ \text{sinc}(t) &= \begin{cases} \frac{\sin(\pi t)}{\pi t}, & t \neq 0, \\ 1, & t = 0. \end{cases} \end{aligned}$$

The sinc function has the useful property that $\text{sinc}(0) = 1$ while $\text{sinc}(n) = 0$ for nonzero integers n.