Overview

1. Complex exponentials are eigenfunctions of LTI systems.

\[ x(t) = \int_{-\infty}^{\infty} X(j\omega) e^{j\omega t} \frac{d\omega}{2\pi} \]

2. Most functions can be expressed as an infinitely dense sum (i.e., an integral) of exponentials.

\[ y(t) = \int_{-\infty}^{\infty} H(j\omega)X(j\omega) e^{j\omega t} \frac{d\omega}{2\pi} \]

3. The frequency content of the output is the frequency content of the input multiplied by the transfer function.

4. The frequency content of the impulse is constant over all frequencies. The impulse response has the frequency content of the transfer function.

5. Convolution in time is equivalent to multiplication in frequency. Thus, for a system in the time domain, the output is the input convolved with the impulse response.

6. Exponentials are more generalized eigenfunctions of LTI systems. The eigenvalue of the eigenfunction \( e^{st} \) is the Laplace transform of \( h(t) \) since

\[ H(s)e^{st} = \frac{e^{st}}{H(s)} \int_{-\infty}^{\infty} h(\tau) e^{s(t-\tau)} d\tau = e^{st} \int_{-\infty}^{\infty} h(\tau) e^{-s\tau} d\tau \]