1 Filter Design

For FIR filters, the LDE is of the form

\[ y(n) = \sum_{m=0}^{M} b_m x(n-m). \]

Picking the \( b_m \) values designs your filter. For a general system, we usually break the input into “chunks” (technical term) in the time domain and perform an FFT. This is then multiplied by the transfer function and then an inverse FFT is performed to get the corresponding “chunk” output. This method is valid because of superposition.

2 Information and Communication

Above we have the general model a communication system. It consists of a source, \( S \), a transmitter, \( XMTR \), a channel, and a receiver, \( RCVR \). The goal of any communication system is to get information from source to a destination.

For TV, the picture is modulated using AM and the sound is modulated using FM. Techniques to modulate signal are chosen based on the type of information you want to transmit and how that information will be effected during the transmission. Also, a transmitter needs to worry about bandwidth; the signal you desire to transmit must fit within the band you are allocated.

In general, transmission is noisy. Often, we assume to noise is additive, meaning

\[ r(t) = x(t) + N_t, \]

where \( N_t \) is the noise term. For wireless systems, the channel is the air and the signal is an electromagnetic wave. For a wireline system, the \( XMTR \) and \( RCVR \) are connected by wires. In wireline communication, we have two models for systems: baseband systems and modulated systems. Since

\[ \lambda f = c, \]

i.e., wavelength of a signal times its frequency is equal to a constant (speed of light), the wavelength is increasing when frequency is decreasing. Thus, baseband communication for wireless systems is not very feasible because we require antennas of length approximately \( \frac{\lambda}{2} \).
In wireline systems, the use of co-axial cable is common. In the figure, the middle wire is made of copper. It is surrounded by dielectric material that is the “shield”. The curly line represents more copper wire wrapped around the shield, and the whole this is encased in insulation. The method of transmitting using a co-axial cable is to induce a voltage, which represents your information signal, across the two copper wires. The major problem with this method is that the cable has some impedance, so your transmitted signal and received signal will differ.