Communication Systems 3 Tutorial 3

1. For the low-pass Butterworth filters

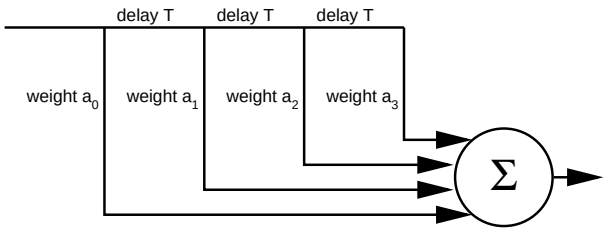
$$|H(\omega)| = \frac{1}{\sqrt{1 + \left(\frac{\omega}{\omega_0}\right)^{2n}}}$$

   What is the bandwidth at the $-3\,\text{dB}$ (power) point ? Find the ratio of the $-60\,\text{dB}$ to $-6\,\text{dB}$ bandwidths for $n = 1$, 2 and 3.

2. Determine the discrete Fourier Transform for the 4 data points representing a sawtooth function $\{0, 1, 2, 3\}$.

3. Determine the discrete Fourier Transform using the FFT algorithm for the 8 data points that consist of your 7-digit student registration number preceded by the value 0. As there is substantial calculation involved, you may wish to do this on a spreadsheet or high-level mathematical application.

4. Find the impulse response function of the four-tap transversal filter shown below. Hence find the frequency transfer function. Determine and sketch the magnitude of the frequency transfer function over $-\pi < \omega T < \pi$ for the particular case in which $a_0 = -1$, $a_1 = 2$, $a_2 = -1$ and $a_3 = 0$.



5. Find the spectrum of a DSB-SC waveform from a chopper amplifier before filtering where $f(t) = \cos \omega_m t$ and the switch in the chopper is approximated with (a) a comb function $\text{III}_{2\pi/\omega_c}(t)$ and (b) a square wave (values 1 and 0) of frequency ω_c with equal mark-to-space ratio.

6. Find the transmission efficiencies for a DSB-LC transmission with a sinusoidal modulation with the following modulation indices m (a) $1/\sqrt{2}$ (b) 50% (c) 10% If the power in the modulation is required to be 1 kW in each case, what should be the total transmitted power ?

7. For the DSB-LC waveform shown below: (a) find the modulation index; (b) write down an expression for this waveform; (c) sketch the spectrum of this waveform; (d) show that the sum of the two sideband lines divided by the carrier line yields the modulation index; (e) determine the amplitude and phase of the additional carrier which must be added to the waveform to attain a modulation index of 20%.