Set #4

Due Friday February 27, 2026

Problems:

1. **To be turned in**. Z&T text 2.55a, c & e, plus compile the results for the Manchester pulse used in the Jupyter examples. The numerical integration aspect of this problem is described in the Chapter 2 Jupyter notebook under the heading *Spectral Containment Bandwidth*. It turns out to be very easy in Python.
2. **To be turned in**. Find the gain in dB, phase, and group delay of Chebyshev (type 1) bandpass filter using

   ```
   b, a = scipy.signal.cheby1(N, rp, 2*pi*array([f1,f2]),
             'bandpass', analog=True)
   ```

   to obtain the numerator `b` and denominator `a`, rational transfer function coefficients, e.g.,

   $$H(s) = \frac{b_0 s^M + b_1 s^{M-1} + \cdots + b_M}{a_0 s^N + a_1 s^{N-1} + \cdots + a_N}.$$

   Assume the filter order is `N=7`, the passband ripple is `rp=1` dB, and the lower and upper passband edge frequencies are `f1=1000` Hz and `f2=2000` Hz. Then use the function in the Chapter 2 Jupyter notebook,

   ```
   freqs_resp(b,a,Dmin=?,Dmax=?,mode ='?',Npts=4096)
   ```

   where `mode` equals `'dB'`, `'phase'`, or `'groupdelay'`, to make plots. The inputs `Dmin` and `Dmax`, set the powers of 10 used for setting up a log frequency axis using `logspace()`. In the dB magnitude plot use `ylim()` to limit the lower gain from going below -80 dB. Adjust `Dmin` and `Dmax` to insure good detail on the filter passband, which means the -80 dB gain point should be near left and right edges of the plot. Note `Dmin` and `Dmax` do not have to be integers.
3. Z&T text 2.61.
4. **To be turned in**. Z&T text 2.62 with

   $$x(t) = \cos(8\pi t) + \cos(3\pi t)$$

   Suggest using Wolfram Alpha for a trig expansion, then identify terms. In Alpha I suggest using a symbolic frequencies say f1 Hz and f2 Hz. This way when factored you will clearly see harmonic and inter-modulation terms.
5. Z&T text 2.64a. A chance to work with a Gaussian pulse shape and spectrum.