1. An LTI filter is described by the LDE:
\[ y(n) = x(n) - x(n-1) + 0.95 y(n-1) \]

(a) Draw the Direct Form II signal flow graph realization of this filter.

(b) Apply the method shown in Lec. 7 to find the impulse response \( h(n) \).

(c) Also find \( h(n) \) by iterating the LDE with \( x(n) = \delta(n) \), then deduce* a closed-form expression for \( h(n) \). Hence verify your answer to (b).

(d) Calculate \( \sum_{n=-\infty}^{\infty} |h(n)| \) and thereby prove whether or not that the filter is BIBO stable.

(e) Apply FREQZ in Matlab to make a plot of the filter’s dB gain vs. \( \omega \) (rad/sample) over the range \( 0 \leq \omega \leq \pi \). (See Lec. 5 & 6 for sample code.) Based on the shape of the gain plot, suggest an application for this digital filter. Attach your code and plot.

* This is only feasible for filters of order 1 or 2.
2. For the digital filter:

\[ y(n) - 0.7y(n-1) + 0.1y(n-2) = 2x(n) - x(n-2) \]

(a) Draw the DFII signal flow graph.

(b) Find a closed-form expression for \( h(n) \)

\[ h(n) = \sum_{k=1}^{N} c_k \gamma_k + \sum_{k=0}^{M-N} A_k \delta(n-k) \quad (k \neq 0) \]

(c) Now apply \( a(n) = \sum_{k=0}^{n} h(k) \) to derive a closed-form expression for the step response \( a(n) \). (L6, p.4 equation)

3. Find \( h(n) \) in closed-form for the second-order digital bandpass filter:

\[ y(n) - 0.8y(n-1) + 0.64y(n-2) = x(n) + x(n-1) \]

(No j-terms in your answer.)

4. Draw signal flow graphs for these filters:

(a) \( 5y(n) - 2y(n-1) + 4y(n-2) = 3x(n-1) - 6x(n-5) \)

(b) FIR filter represented by the stem plot of \( h(n) \) on Lec 5, p.2. (It's ok to approximate the numerical values of the filter coefficients; read them from the stem plot as best you can, or use Matlab to generate them using the given code.)
5. Five LTI filters are interconnected as shown:

\[ x(n) \rightarrow h_1(n) \rightarrow h_2(n) \rightarrow h_3(n) \rightarrow h_4(n) \rightarrow h_5(n) \rightarrow y(n) \]

(a) Applying properties of convolution learned in ECE 340, express the overall impulse response in terms of
\[ h_1(n) \rightarrow h_5(n). \]

(b) Determine the overall impulse response \( h(n) \) when
\[ h_1(n) = \{-1, 2, -1\} \]
\[ h_2(n) = (n+1)u(n) \]
\[ h_3(n) = \delta(n-2) \]
\[ h_4(n) = h_2(n) \]
\[ h_5(n) = \delta(n-4) \]

(The convolution relationship
\[ g(n) \ast \delta(n-m) = g(n-m) \]
... might be useful.)