Tools to Analyze and Design Discrete Time Linear Filters

1. One pole at *a* and one zero at zero (set a=0) $y[n] = x[n] + by[n-1] \quad H(z) = \frac{z}{z-b}$

2. One pole at *b* and one zero at a $y[n] = -by[n-1] + x[n] + ax[n-1] \quad H(z) = \frac{z-a}{z-b}$

3. Pair of complex poles and two zeros at zero

$$y[n] = x[n] + 2b\cos(\phi)y[n-1] - b^2 y[n-2] \quad H(z) = \frac{z^2}{z^2 - 2b\cos(\phi)z + b^2}$$

4. Pair of complex zeros and two poles at zero

$$y[n] = x[n] + 2a\cos(\theta)x[n-1] - a^2 x[n-2] \quad H(z) = \frac{z^2 - 2a\cos(\theta)z + a^2}{z^2}$$

5. Pair of complex zeros and pair of complex poles

$$y[n] = x[n] + 2a\cos(\theta)x[n-1] - a^2 x[n-2] + 2b\cos(\phi)y[n-1] - b^2 y[n-2] \quad H(z) = \frac{z^2 - 2a\cos(\theta)z + a^2}{z^2 - 2b\cos(\phi)z + b^2}$$

6. Design of First and Second Order Digital Filters (Combines tools in 1-5 above)

7. MATLAB filter design tool equivalent to the LabVIEW module 8.1 can be found at 8.1: Discrete-Time Frequency Response from Poles and Zeros. This tool supports 3 poles and 3 zeros. (Also see code provided with the on-line version of the text book at: MATLAB versions of some LabVIEW modules.) In this tool the angle of the poles and zeros is normalized by pi. Example for zeros at +/-pi/4 (45 degrees) inter 0.25.

8. Mathematica tool for Transfer Function Analysis by Manipulation of Poles and Zeros. This tool supports 4 poles and 4 zeros.