Experiment No: 5 – Digital IIR filter design using Matlab/Octave

1) Design a low pass ***digital*** Butterworth filter which has a maximum passband ripple of -2 dB and an edge frequency of 10 Hz ($\Omega_p = 20\pi$ rad/sec). The filter also should have a minimum stopband attenuation of -40 dB from a stopband edge frequency of 20 Hz ($\Omega_p = 40\pi$ rad/sec). Assume a sampling frequency of 720 samples/sec.

   IMP: You have to normalize the frequency Ω (rad/sec) by the folding frequency $\frac{F_s}{2}$ *(NOT with* F_s*) i.e.,* $\frac{\Omega}{\pi F_s}$*. You can do the complete experiment in digital-domain.*

   a. Find the transfer function of the filter (using $sys1 = tf(b, a, 1/F_s)$)
   b. Plot its pole zero plot.
   c. Plot also the bode plot.

   For bode, use $[Mag\ Ph] = bode(sys1, 2 * pi * linspace(0,50,100))$ and later plot the two subplots (Mag and Ph.) with respect to $F = linspace(0,50,100)$ in Hz

2) Try the above design specifications with Type I Chebyshev's filter. Compare the system order w.r.t Butterworth. Also plot the bode plot.

3) Compare (plot on the same graph with legends) the impulse response$[Y, T] = impulse\left(sys, TFINAL, \frac{1}{F_s}\right)$, and step response of the two filters for a duration of $TFINAL = 1$ secs. Write down your observations.

Important: Some of the important functions in Octave/Matlab for performing this experiment: *buttord*(), *butter*(), *pzmap*(), *bode*(), *zpk*(), *fft*(), *cheb1ord*(), *cheby1*(),*cheb2ord*(), *cheby2*(),*ellipord*(),*ellip*(), *impulse*(), *step*(),*filter*()