UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

School of Electrical and Information Engineering

ELEN 3013 Signals and Systems IIB

Tutorial 4

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1. Given an analog filter

$$H(s) = \frac{10}{s+10},$$

Convert this to digital filter transfer function using Bilinear Transformation (BLT) and obtain the equivalent difference equation, respectively, when a sampling period is given as $T = 0.01$ second.

2. Assume the following analog frequencies:

$\omega_a = 10\ rad/s$,

$\omega_a = 50\pi\ rad/s$.

With respect to the analog filter and the developed digital filter transfer function in (1), determine the corresponding digital frequencies.

3. The normalized lowpass filter with a cut-off frequency of 1 rad/s is given as

$$\mathcal{H}_a(s) = \frac{1}{s+1}.$$

   (a.) Use the given $\mathcal{H}_a(s)$ and Bilinear Transformation to design a corresponding digital IIR lowpass filter with a cutoff frequency of 15 Hz and a sampling rate of 90 Hz.

   (b.) Use MATLAB to plot the magnitude response and phase response of $H(z)$.

4. Design a digital highpass Butterworth filter using the bilinear transformation with prewarping to satisfy the following:

   $|H[(e^{j\omega T})]| = 0.7943\ \ at\ \omega = \omega_p = 150\pi\ rad/s$

   $|H[(e^{j\omega T})]| = 0.3162\ at\ \ \omega = \omega_s = 100\pi\ rad/s$,

   where ω_p= passband cut off frequency, and ω_s= stopband cut off frequency.The highest significant frequency to be processed is f_h=200 Hz.

5. Repeat (4) for a Chebychev filter.