ECEn 487 - Introduction to Digital Signal Processing

Winter 2013

Quiz 8

1. (2 pts) A discrete-time lowpass filter is to be designed by applying the impulse invariance method to a continuous-tim Butterworth filter having magnitude-squared function

$$|H_C\left(j\Omega\right)^2| = \frac{1}{1+\left(\Omega/\Omega_c\right)^{2N}}$$

The specifications for the discrete-time system are as follows:

$$\begin{aligned} 0.9 \leq |H\left(e^{j\omega}\right)| \leq 1, \quad & 0 \leq |\omega| \leq 0.3\pi \\ |H\left(e^{j\omega}\right)| \leq 0.1, \quad & 0.5\pi \leq |\omega| \leq \pi \end{aligned}$$

Assume that aliasing will not be a problem.

a) (3 pts) Sketch the tolerance bounds of on the magnitude of the frequency response, $|H_c\left(j\Omega\right)|$, of the continuous-time Butterworth filter such that after the applicationof the impulse invariance method ($h[n] = T_d h_c\left(nT_d\right)$), the resulting discrete-time filter will satisfy the given design specifications.

b) (7 pts) Determine the integer order N and the quantity $T_d\Omega_c$ such that the continuous-time Butterworth filter exactly meets the specifications determined in part (a) at the passband edge.