ESE 547 Fall 2009; October 28

Class	Topics	Sections	Reading
9	Impulse-Invariance IIR Filter Design Examples	Notes	
	Bilinear Transform IIR Filter Design	9.2	Sec. 9.1
	Bilinear Transform Design Examples	9.3, 9.4	

Homework:

1. If
$$H_a(s) = \frac{\lambda}{(s+\beta)^2 + \lambda^2}$$
show that the corresponding digital transfer function obtained by impulse invariance is
$$H(z) = \frac{e^{-\beta T}\sin(\lambda T)z^{-1}}{1 - 2e^{-\beta T}\cos(\lambda T)z^{-1} + e^{-2\beta T}z^{-2}}$$

2. If
$$H_a(s) = \frac{s+\beta}{(s+\beta)^2 + \lambda^2}$$
show that the corresponding digital transfer function obtained by impulse invariance is
$$H(z) = \frac{1 - e^{-\beta T}\cos(\lambda T)z^{-1}}{1 - 2e^{-\beta T}\cos(\lambda T)z^{-1} + e^{-2\beta T}z^{-2}}$$

3. Chapter 9: Problems 9(a & b), 10, 15, 30, and 32, p. 517.

   (For the previous edition, do Chapter 7: Problems 7, 7, 12(a), 20, 41, and 43, p. 499.)

4. For a system with a sampling rate of 12kHz, a lowpass filter is needed with 3-dB point at 4kHz, and unity gain at DC. Use the Bilinear transform, starting with a Butterworth filter, to find a second-order lowpass filter to meet these specifications.

5. For a system with a sampling rate of 10kHz, a low-pass filter is needed with 3-dB point at 2kHz. Use the Bilinear transform, starting with a Butterworth filter, to find a third-order high-pass filter to meet these specifications. Draw a signal flow-graph for your filter.

   The transfer function of a third-order, unity-gain, high-pass, Butterworth analog filter with 3-dB angular frequency Ω_c is given by
$$H(S) = \frac{\Omega_c^2}{S^2 + \Omega_c S + \Omega_c^2} \times \frac{\Omega_c}{S + \Omega_c}$$