University of Victoria
Department of Electrical and Computer Engineering
ELEC 310-Spring 2010
Assignment 4 worth 3% of final course mark

Issued: March 18, 2010 **Due: March 25, 2010, 4:00 pm**
Please use the ELEC 310 drop box by the ELW 2nd floor elevator

Problem 1.

Consider the signal $y(t)=x_1(t)*x_2(t)*x_3(t)$ where * stands for continuous-time convolution.
We know that:
$X_1(j\Omega)=0 \quad \text{for } |\Omega|>500\pi$
$X_2(j\Omega)=0 \quad \text{for } |\Omega|>1000\pi$
$X_3(j\Omega)=0 \quad \text{for } |\Omega|>1500\pi$

The signal y(t) is sampled using a periodic impulse train. Specify the range of values for the sampling period T which ensures that y(t) is recoverable from $y_p(t)$.

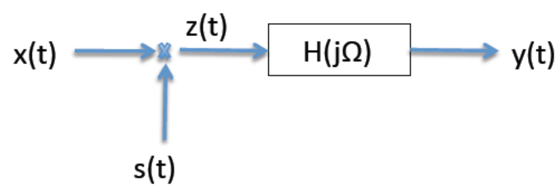
Problem 2.

Consider a system that processes continuous-time signals using a digital filter h[n] that is linear and causal with difference equation:

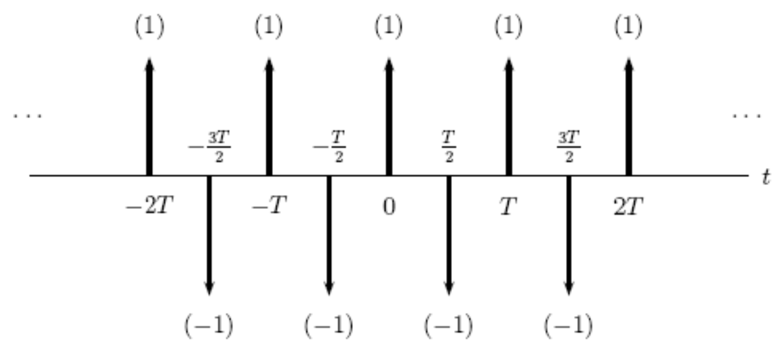
$$y[n]=\frac{3}{4}y[n-2]+x[n]+\frac{1}{4}x[n-1]$$

For input signals that are band-limited such that $X_c(j\Omega)=0$ for $|\Omega| \geq \pi/T$, the system is equivalent to a continuous-time LTI system.
Determine the frequency response $H_c(j\Omega)$ of the equivalent overall system with input $x_c(t)$ and output $y_c(t)$.

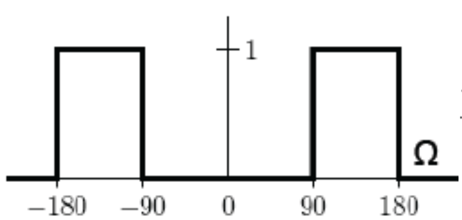
Problem 3.
A sinusoidal input signal x(t)=cos(10t) is sampled and filtered as shown below.

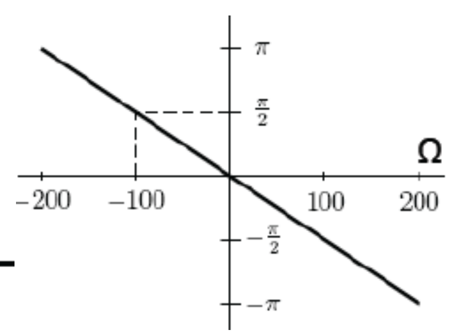


The sampling function s(t) is given below, with $T = \dfrac{2\pi}{90}$.



The frequency response of the filter is $H(j\omega) = |H(j\Omega)| \cdot e^{\angle H(j\Omega)}$ where the magnitude $|H(j\Omega)|$ and the phase $\angle H(j\Omega)$ are sketched below on the left side and right side respectively.





a) Provide a labeled sketch of Z(jΩ), the Fourier transform of z(t).
b) Determine y(t).

Problem 4.

A signal x[n] has the property that

$$\left(x[n]\sum_{k=-\infty}^{\infty}\delta[n-3k]\right) * \left(\frac{\sin\frac{\pi}{3}n}{\frac{\pi}{3}n}\right) = x[n]$$

For what values of ω is it guaranteed that $X(e^{j\omega}) = 0$?

Problem 5.

Consider an ideal DT LTI filter with impulse response h[n]. The frequency response of the filter in the [-π, π] interval is

$$H(e^{j\omega}) = \begin{cases} 1 & |\omega| \le \frac{\pi}{4} \; and \; |\omega| \ge \frac{3\pi}{4} \\ & 0 \text{ elsewhere} \end{cases}$$

Determine the frequency response $H_1(e^{j\omega})$ of the filter whose impulse response is $h_1[n] = h[2n]$.