6.s02: EECS II - From A Medical Perspective

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1. (a) The fundamental period of this DT signal is $N = 7$. Let $\Omega_0 = \frac{2\pi}{7}$

   Evaluating the synthesis equation for the period of $X[k]$ between $k = -3$ and $k = 3$

   $$x[n] = \frac{1}{2}\left(e^{j2\Omega_0 n} + e^{-j2\Omega_0 n}\right)$$

   $$x[n] = \cos\left(2\Omega_0 n\right) = \cos\left(\tfrac{4\pi}{7} n\right)$$

   (b) $x[n] = \cos\left(\Omega n\right)$

   $$\omega = \frac{\Omega}{T_s} = \frac{\frac{4\pi}{7}}{0.1} = \frac{40\pi}{7}$$

   $$x[t] = \cos\left(\omega t\right) = \cos\left(\frac{40\pi}{7} t\right)$$

   (c) The fundamental period of this DT signal is $N = 7$. Let $\Omega_0 = \frac{2\pi}{7}$

   Evaluating the synthesis equation for the period of $X[k]$ between $k = -3$ and $k = 3$

   $$x[n] = \frac{1}{2}\left(e^{j3\Omega_0 n} + e^{-j3\Omega_0 n}\right)$$

   $$x[n] = \cos\left(3\Omega_0 n\right) = \cos\left(\tfrac{6\pi}{7} n\right)$$

   (d) $x[n] = \cos\left(\Omega n\right)$

   $$\omega = \frac{\Omega}{T_s} = \frac{\frac{6\pi}{7}}{0.15} = \frac{40\pi}{7}$$

   $$x[t] = \cos\left(\omega t\right) = \cos\left(\frac{40\pi}{7} t\right)$$

2. (a) $H_d[k] = \dfrac{I[k]}{Q[k]}$

We want to solve for $I[k]$

$I[t] = Q[t] - Q[t-1] \implies I[k] = Q[k]\left(1 - e^{-j\Omega_0 k}\right)$

$\therefore H_d[k] = 1 - e^{-j\Omega_0 k}$

(b) $H_a[k] = (H_d[k])^{-1}$

$$H_a[k] = \frac{1}{1 - e^{-j\Omega_0 k}}$$

(c)

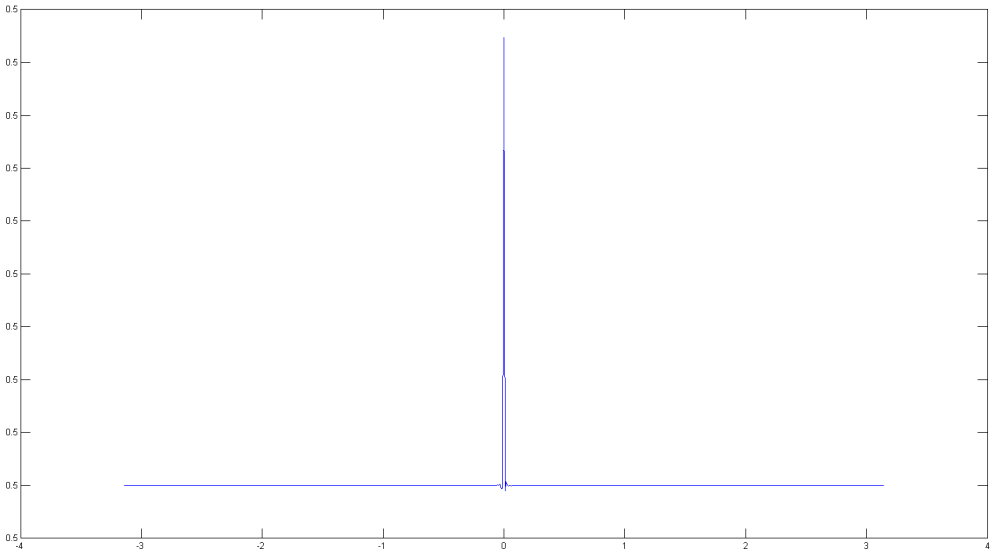

Figure 1: H_a low-pass filter.

3. (a) $y[n] = \left(\sum_{i=1}^{3} \alpha^i\right)^{-1} \left(\alpha x[n] + \alpha^2 x[n-1] + \alpha^3 x[n-2]\right)$

$y[n] = (1.952)^{-1} \left(0.8x[n] + 0.64x[n-1] + 0.512x[n-2]\right)$

(b) Adding in the appropriate coefficients from Lab 3's prelab yields

$H[k] = \left(\frac{1}{3} \times \frac{1}{\sum_{i=1}^{3} \alpha^i}\right) \left(\alpha^1 + \alpha^2 e^{-jk\omega} + \alpha^3 e^{-2jk\omega}\right)$

$H[k] = (0.171) \left(0.8 + 0.64e^{-jk\omega} + 0.512e^{-2jk\omega}\right)$

4. (a)

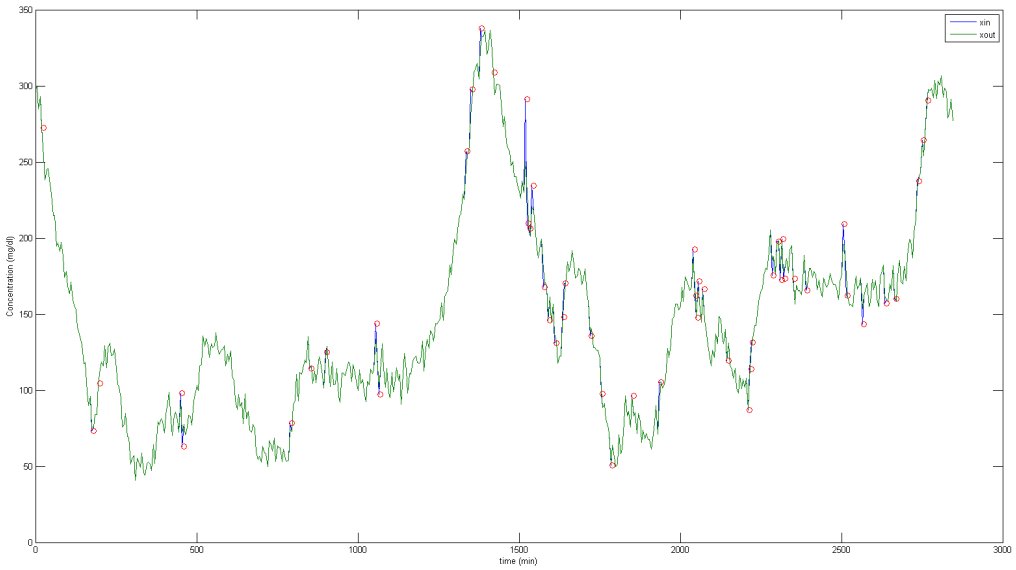

Figure 2: Continuous glucose monitor with overlay of signal with artifacts removed. Points where sensor input was altered is highlighted with red circles.

```
function [xout, changes] = cgmprefilter(xin, t)
    len = length(t);
    xout = zeros(len, 1);
    changes = zeros(len, 1);
    xout(1) = xin(1);
    for i = 2:length(t)
        diff = xin(i) - xout(i-1);
        if (abs(diff) > 20)
            changes(i) = 1;
            if (diff > 0)
                xout(i) = xout(i-1) + 20;
            else
                xout(i) = xout(i-1) - 20;
            end
        else
            xout(i) = xin(i);
        end
    end
end
```

(b) Input data altered at 52 locations.