ECE310: Quiz#10 (6pm Section CSS) Fall 2018

1. (5 pts) A communications signal $x_c(t)$ is assumed to be bandlimited to 300 MHz. It is desired to filter this signal with a **lowpass** filter with cutoff of 100 MHz, by using a digital filter with frequency response $H_d(\omega)$ sandwiched between an ideal A/D and an ideal D/A.

   (a) Determine the Nyquist sampling rate for the input signal, and specify the frequency response $H_d(\omega)$ for the necessary discrete-time filter, when sampling at the Nyquist rate.

   (b) Smart Alec claims that the system can perform the desired filtering function even when the sampling rate is lower than the Nyquist rate. Is this true? Justify your answer.

2. (5 pts) A system for processing analog signals $x_c(t)$ is composed of the following parts, connected in cascade: (i) an analog LPF with frequency response

$$G_a(\Omega) = \begin{cases} 1 - 0.5\frac{|\Omega|}{\Omega_c} & \text{for } |\Omega| \leq \Omega_c \\ 0 & \text{for } |\Omega| > \Omega_c \end{cases}$$

   followed by (ii) a causal digital system whose input $x[n]$ and output $y[n]$ are related as

$$y[n] + 0.5y[n-3] + x[n] = 0$$

   which is sandwiched between an ideal A/D and an ideal D/A operating at a sampling rate of 50 kHz. The output of this entire system is denoted by $y_c(t)$.

   (a) What is the largest value of Ω_c for which the entire system will act as an analog LTI system, from input $x_c(t)$ to output $y_c(t)$? Justify your answer.

   (b) For the Ω_c determined in (a), determine the analog frequency response $H_c(\Omega)$ of the entire system from input x_c to output y_c.