1. Consider the continuous-time to discrete-time (C-to-D) converter shown in Figure 1 below. For all questions below, assume that the sample rate is $1/T = 10$ kHz and be sure to state whether aliasing occurs for each input considered.

![Continuous-time to discrete-time converter](image)

Figure 1: Continuous-time to discrete-time converter.

(a) Determine $x[n]$ and $X(e^{j2\pi\lambda})$ given

$$x_c(t) = \sin(2\pi(1kHz)t).$$

(b) Determine $x[n]$ and $X(e^{j2\pi\lambda})$ given

$$x_c(t) = \sin(2\pi(11kHz)t).$$

(c) Determine $x[n]$ and $X(e^{j2\pi\lambda})$ given

$$x_c(t) = \sin(2\pi(1kHz)) + \cos(2\pi(11kHz)) + \cos(2\pi(10kHz)).$$

(d) Given $x_c(t) = \sin(2\pi f_c t)$, what is the highest value of $f_c$ such that aliasing does not occur?
2. Consider the discrete-time to continuous-time (D-to-C) converter shown in Figure 2. Note that the reconstruction filter has an impulse response, \( h(t) \), as shown in the figure.

![Figure 2: Discrete-time to continuous-time converter.](image)

(a) Calculate the frequency response of the analog reconstruction filter, \( H(j2\pi f) \) (which is the Fourier Transform of \( h(t) \)). Hint: you can avoid doing allot of math by leveraging the fact that \( h(t) \) can be viewed as the convolution of \( a(t) \) with itself as shown below (you’ll learn why this is true in 6.003).

![Figure 3: Hint for Problem 2, Part (a).](image)

(b) Based on your results in part (a), is the given reconstruction filter better or worse at suppressing higher frequency replicas of the signal compared to the Zero-Order Hold reconstruction filter described in lecture? Be sure to justify your answer (hint: consider the magnitude of the frequency responses for each reconstruction filter — feel free to use Matlab to plot these responses and compare to each other).

(c) Given \( y[n] \) as shown in the figure, draw \( y_c(t) \) assuming the given reconstruction filter impulse response, \( h(t) \). Be sure to label your plot appropriately. (Hint: determine the plot in the time-domain rather than frequency domain).