

Name: Kevin Morales

ICE: Section 1.4: Sinusoid Aliasing**Example 1.4.7:** Consider a sound wave of the form

$$x(t) = 2A \cos(10\pi t) + 2B \cos(30\pi t) + 2C \cos(50\pi t) + 2D \cos(60\pi t) + 2E \cos(90\pi t) + 2F \cos(125\pi t)$$

$\begin{matrix} 5\text{K} & 15\text{K} & 25\text{K} & 30\text{K} & 45\text{K} & 62.5\text{K} \end{matrix}$

where t is in milliseconds.

What is the frequency content of this signal? Which parts are audible?

frequency content (kHz): 5, 15, 25, 30, 45, 62.5

audible parts: $2A \cos(10\pi t) + 2B \cos(30\pi t)$

This signal is prefiltered with an antialiasing filter $H(f)$, resulting in signal $y(t)$. Then $y(t)$ is sampled with $f_s = 40\text{kHz}$ and immediately reconstructed with an ideal analog reconstructor, resulting in signal $y_a(t)$.

Determine $y(t)$ and $y_a(t)$ if:(a) $H(f) = 1, \forall f$.

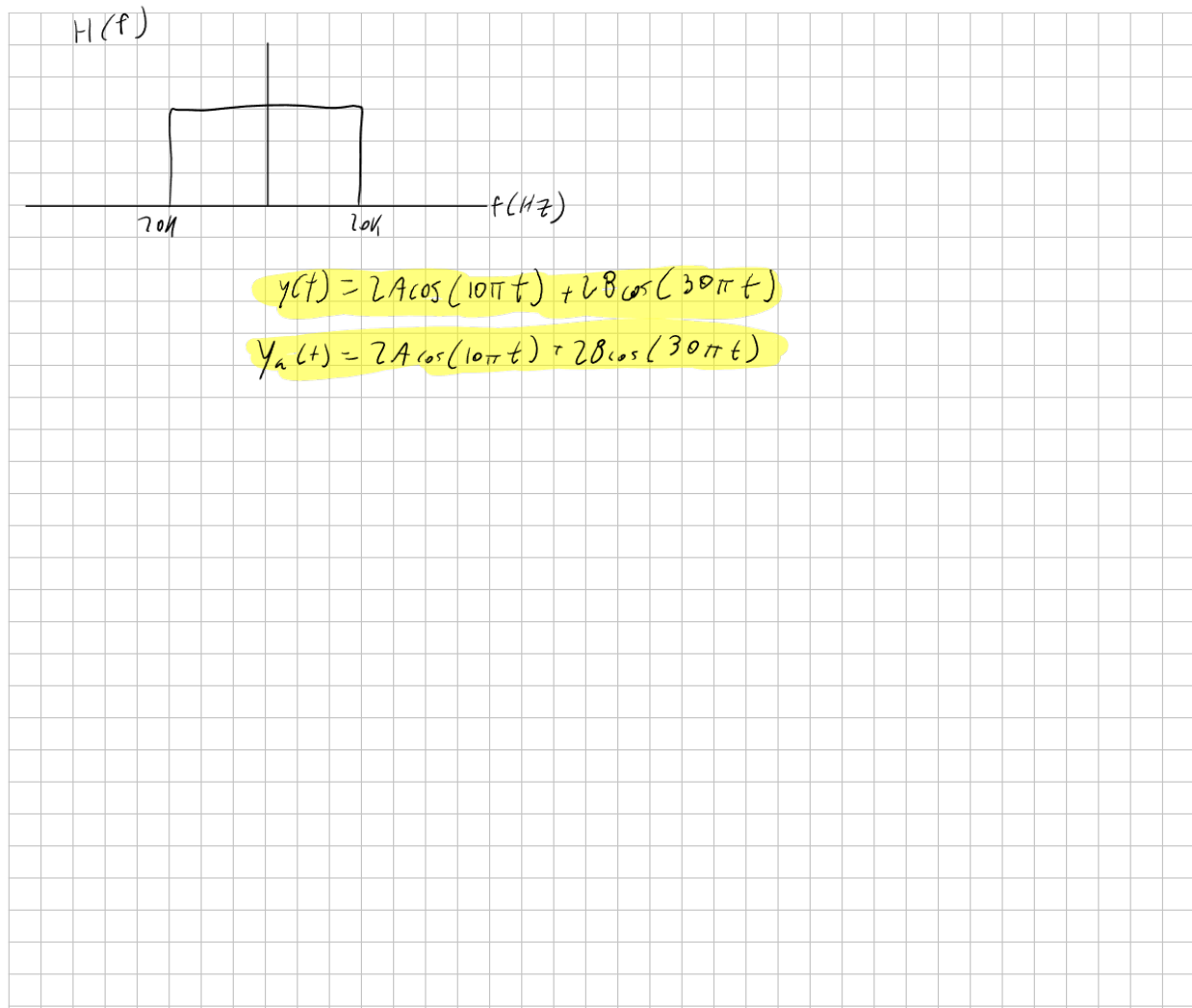
$$y(t) = 2A \cos(10\pi t) + 2B \cos(30\pi t) + 2C \cos(50\pi t) + 2D \cos(60\pi t) + 2E \cos(90\pi t) + 2F \cos(125\pi t)$$

$f_s = 40\text{K}$ $f_{a1} = 5\text{K}$ $f_{a2} = 15\text{K}$ $f_{a3} = 25\text{K} - 40\text{K} = -15\text{K}$ $f_{a4} = 30\text{K} - 40\text{K} = -10\text{K}$ $f_{a5} = 45\text{K} - 40\text{K} = 5\text{K}$ $f_{a6} = 62.5\text{K} - 40\text{K} = 22.5\text{K} - 40\text{K} = -17.5\text{K}$

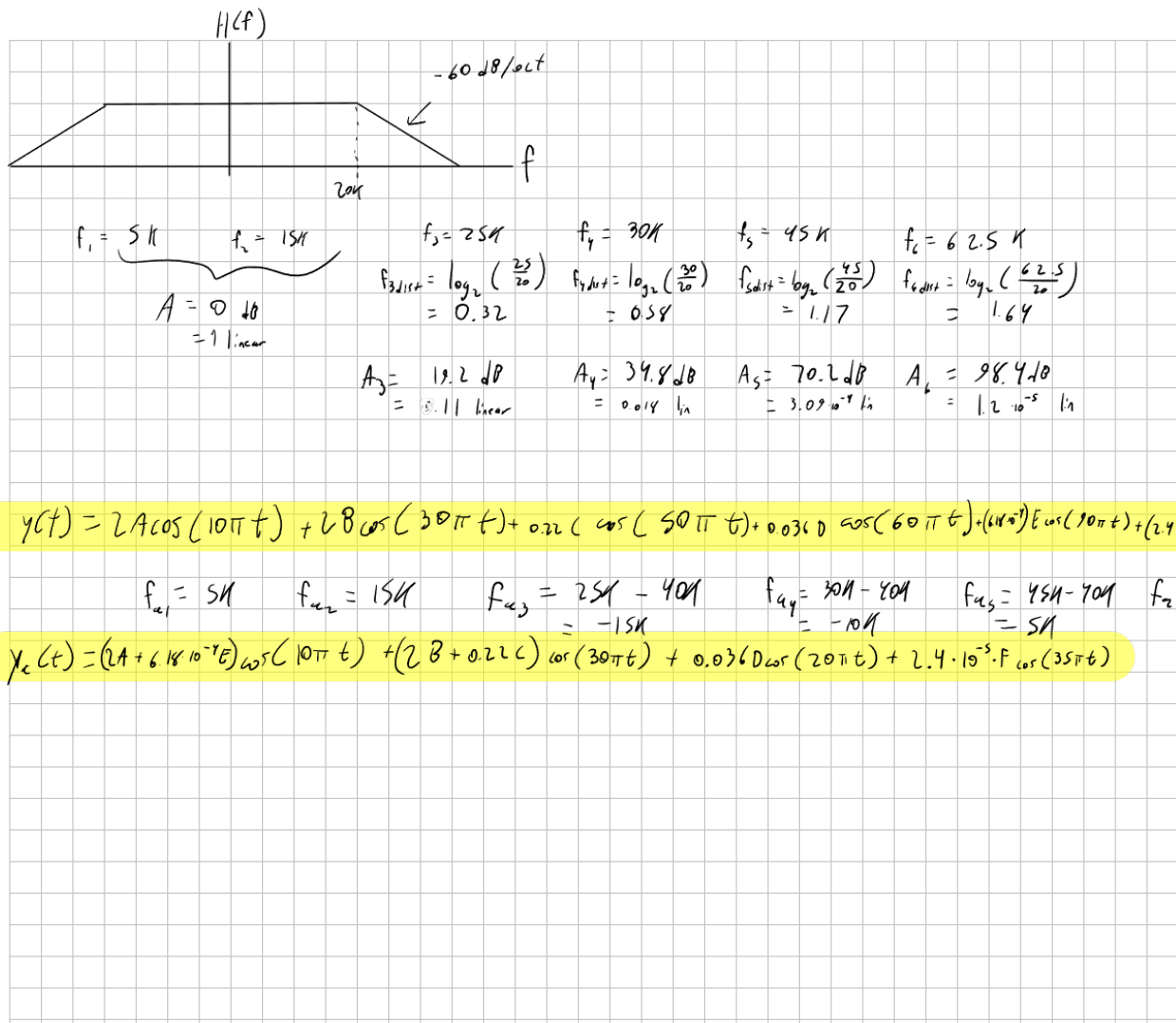
$$y_a(t) = 2A \cos(10\pi t) + 2B \cos(30\pi t) + 2C \cos(30\pi t) + 2D \cos(20\pi t) + 2E \cos(10\pi t) + 2F \cos(35\pi t)$$

$$y_a(t) = (2A + 2E) \cos(10\pi t) + (2B + 2C) \cos(30\pi t) + 2D \cos(20\pi t) + 2F \cos(35\pi t)$$

(b) $H(f)$ is an ideal lowpass filter with cutoff frequency $f_s/2 = 20\text{kHz}$.



(c) $H(f)$ is a practical prefilter with gain 1 through $f = 20\text{kHz}$ and a rolloff of -60 dB/octave after $f = 20\text{kHz}$.



(d) Repeat part (c) but for $H(f)$ as a practical prefilter with gain 1 through $f = 30\text{kHz}$ and a rolloff of -30dB/octave after $f = 30\text{kHz}$.

