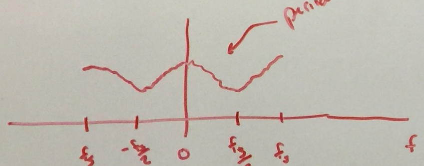
$x(n) \rightarrow \boxed{H(z)} \rightarrow y(n)$

① Given $H(z)$

$$H(f) = H(z)\Big|_{z=e^{j2\pi\frac{f}{f_s}}}$$

periodic @ f_s



② Given $h(n)$:

$$h(n) = [h_0\ h_1\ h_2 \dots h_N]$$

$$H(z) = h_0 + h_1 z^{-1} + h_2 z^{-2} + \dots + h_N z^{-N}$$

$$h(n) = h_0\delta(n) + h_1\delta(n-1) + h_2\delta(n-2) + \dots h_N\delta(n-N)$$

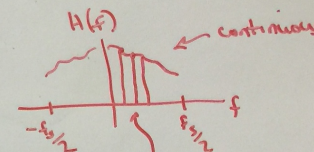
$z = e^{j\omega}$

Discrete Fourier Transform:

$$H(e^{j\omega}) = \sum_{n=-\infty}^{\infty} h(n)\, e^{-j\omega}$$

$$\omega_k = \frac{2\pi k}{N}$$

$$H(k) = \sum_{n=0}^{N-1} h(n)\, e^{-j2\pi k/N}$$



$\frac{2\pi}{N} \propto \frac{f_s}{N}$

frequency resolution $\propto \frac{1}{N}$

Ex: $f_s = 8000$ Hz

20 Hz resolution

$20\text{ Hz} = \frac{f_s}{N} \Rightarrow N = \frac{f_s}{20\text{ Hz}} = \frac{8000}{20} = 400$

Even better $N = 8{,}000$?

Time Bandwidth product