Equations ★watch your units

① Thermistor:

$$BW = F_s \cdot S_s \qquad \left[\frac{b}{s} \text{ or } \frac{B}{s}\right]$$

F_s: samp freq (samp/s)

S_s: sample size

$$T_o \text{ (operation time)} = \frac{MEM}{BW} \qquad [s]$$

MEM: size of memory

② Accelerometer:

★ same as thermistor but multiply S_s by the # of dimensions/axis

Ex. 3D accel

$$BW = F_s \cdot 3(S_s)$$

③ Sound:

★ Same, but multiply S_s by # of channels

$$BW = F_s \cdot 2(S_s)$$

↳ L/R channels (stereo)

④ Video:

$$BW = F_s \cdot \#\text{of components} \cdot N \cdot M \cdot S_s$$

3 for RGB

N, M: screen dimensions

★ have to find and add Audio BW

$$T_o = \frac{MEM}{(BW_V + BW_A)}$$

Discrete Moving Average Eq

$$y[n] = 0.5y[n-1] + x[n] + x[n-1]$$

* needs to be initialized so at $y[0]$ you have valid values for $y[n-1]$ and $x[n-1]$.

AD Converter

- Range: $0 \ldots 2^n - 1$
- Resolution: $\Delta = \frac{\text{range}}{\#\text{ of steps}} = \frac{V_{r+} - V_{r-}}{2^n - 1}$ (quantization step)
- Output: $N_{adc} = \frac{V_{in} - V_{r-}}{\Delta}$

* if your input V_{in} is outside of your V_{ref} range, then it will be V_{ref}.

Ex. $V_{r-} = 0.5\,V$ $V_{r+} = 2.5$

$V_{in} = 3 \rightarrow$ answer is N_{adc} at 2.5

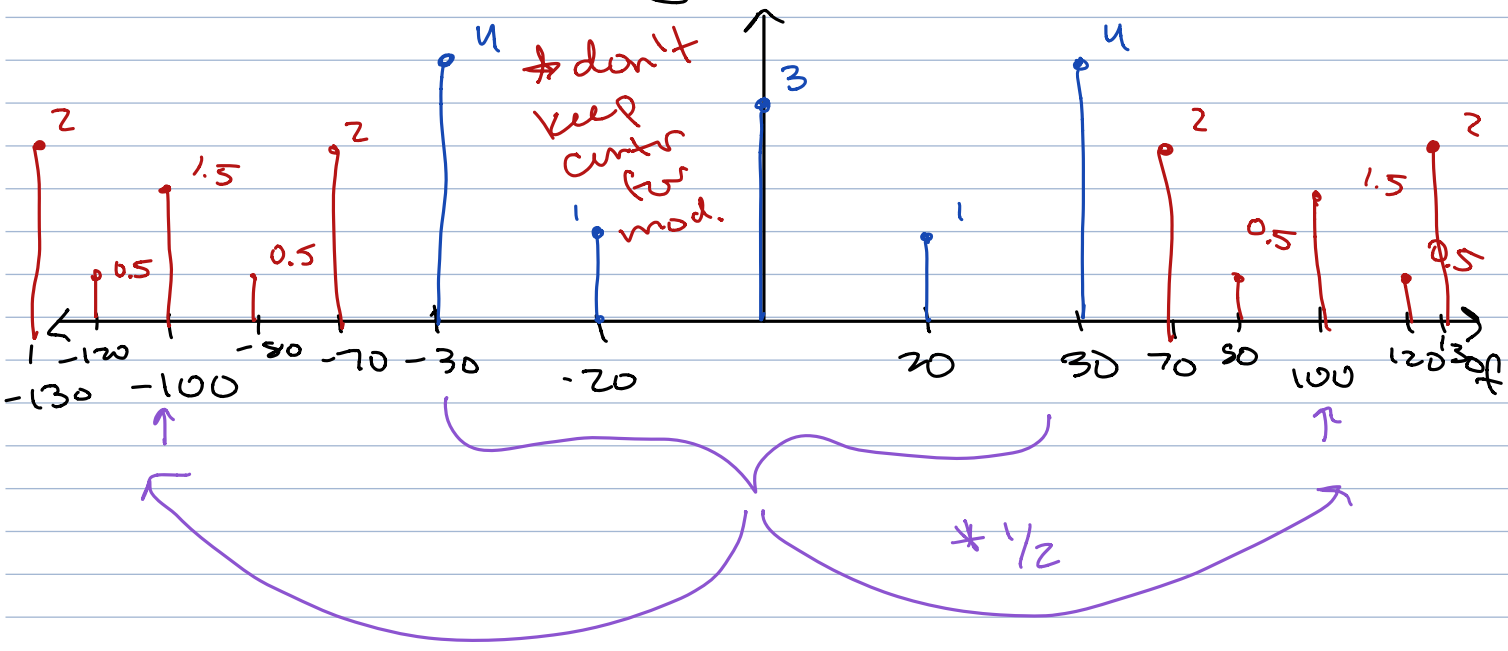
$V_{in} = -2V \rightarrow$ answer is N_{adc} at 0

* from Jovanov → round down

Modulation → you are multiplying 2 functions

→ Orig = $3 + 2\sin(20t) + 8\cos(30t)$

→ mod = Orig · $\cos(100t)$



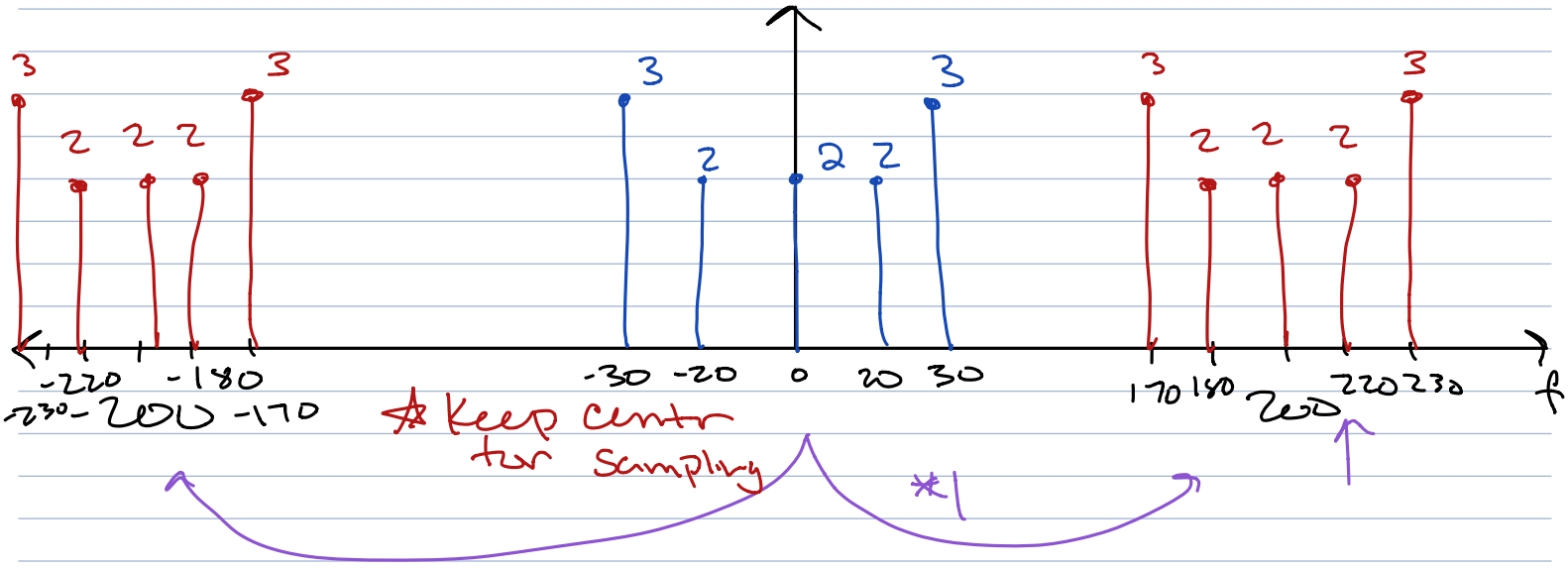
Sampling

Repeat at every multiple of F_s

→ $y(t) = 2 + 4\sin(20t) + 6\cos(30t)$

→ Sample at freq. 200.

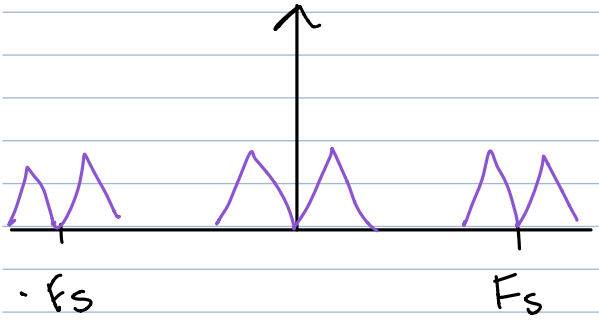
→ What is magnitude at $f = 220$?



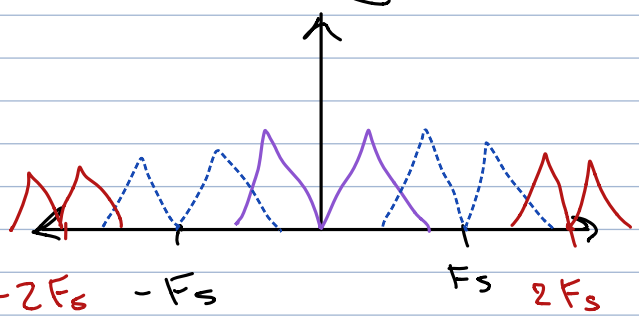
Nyquist Sampling Eq.

$\Omega_s \geq 2\Omega_{max}$ → tells you if you have aliasing

Normal Sampling

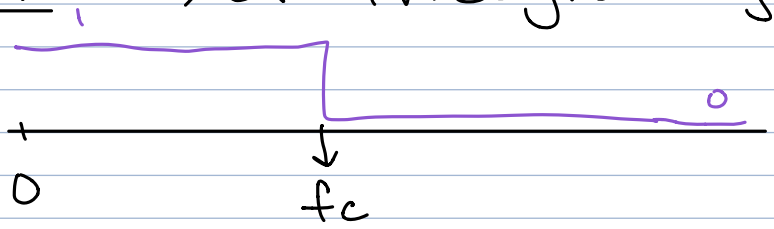


Sampling w/ aliasing

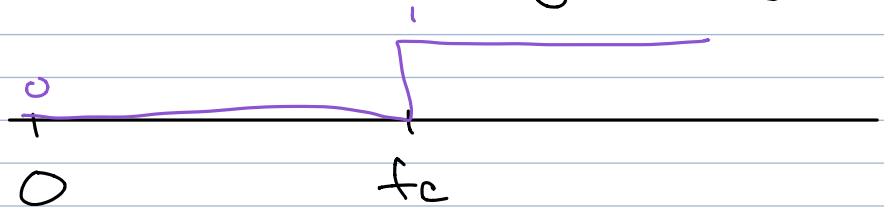


Filters

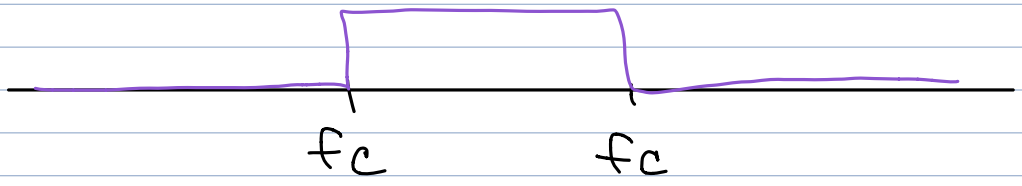
LPF → let through only low freq.



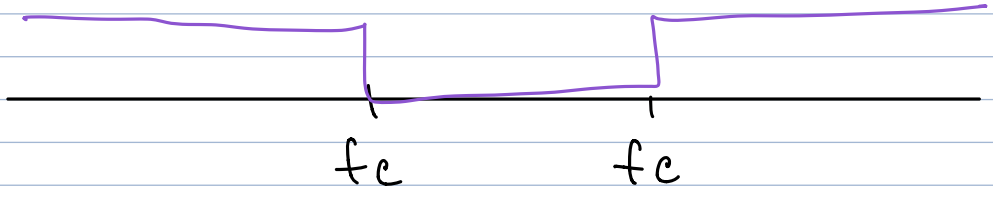
HPF → let through only high freq.



Band Pass → let through range

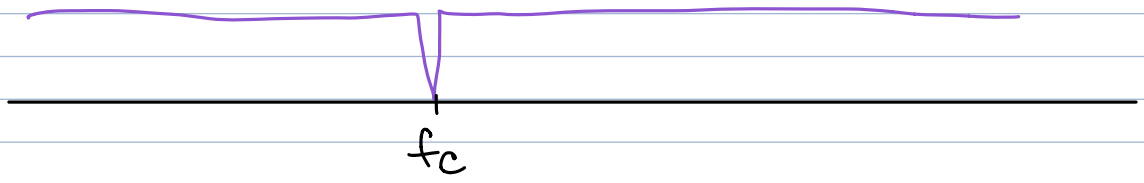


Band Stop → stop a range

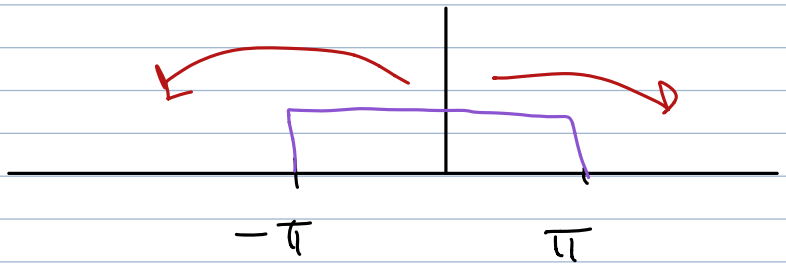


All Pass → everything goes (no fc)

Notched → stop one value



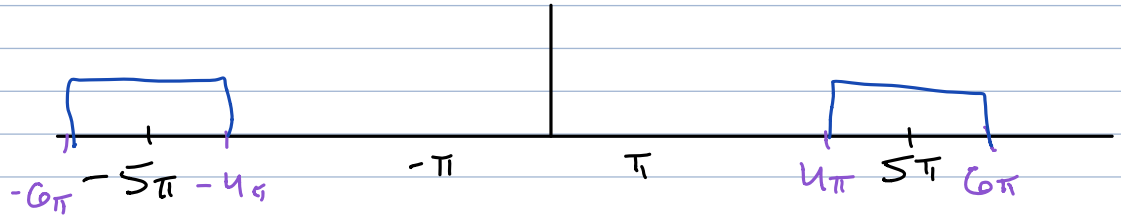
LPF



$\frac{\sin(\pi t)}{\pi t}$

Shift by 5π

$\frac{\sin(\pi t)}{\pi t} \cdot \cos(5\pi t)$



→ now a band pass filter

* know filter circuits