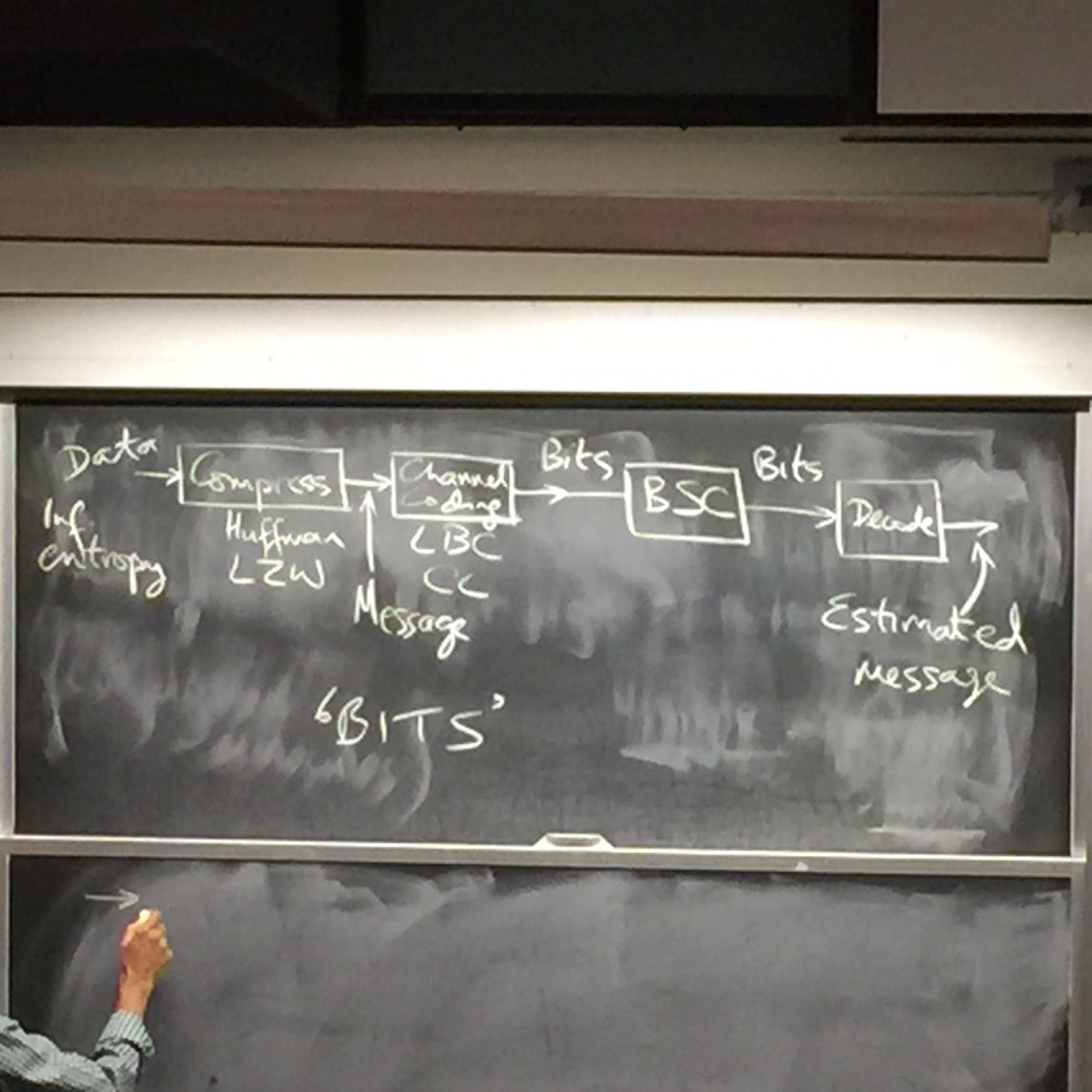

Data
Compress
Channel Coding
Bits
BSC
Bits
Decode
Inf. entropy
Huffman
LZW
LBC
CC
Message
Estimated message
'BITS'

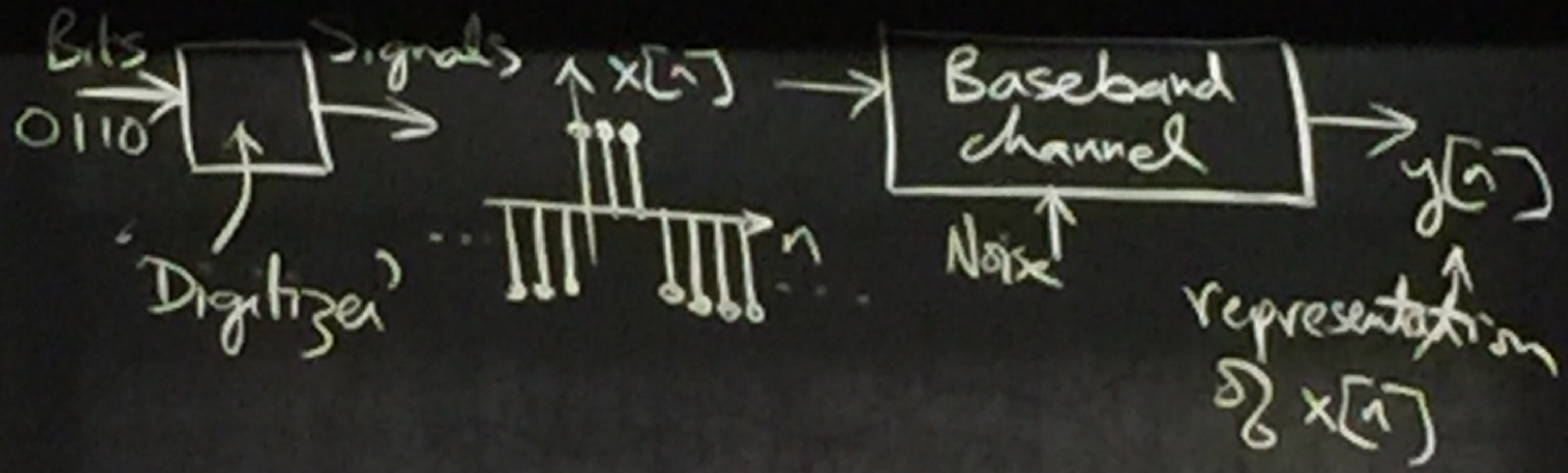
Binary Symmetric Channel

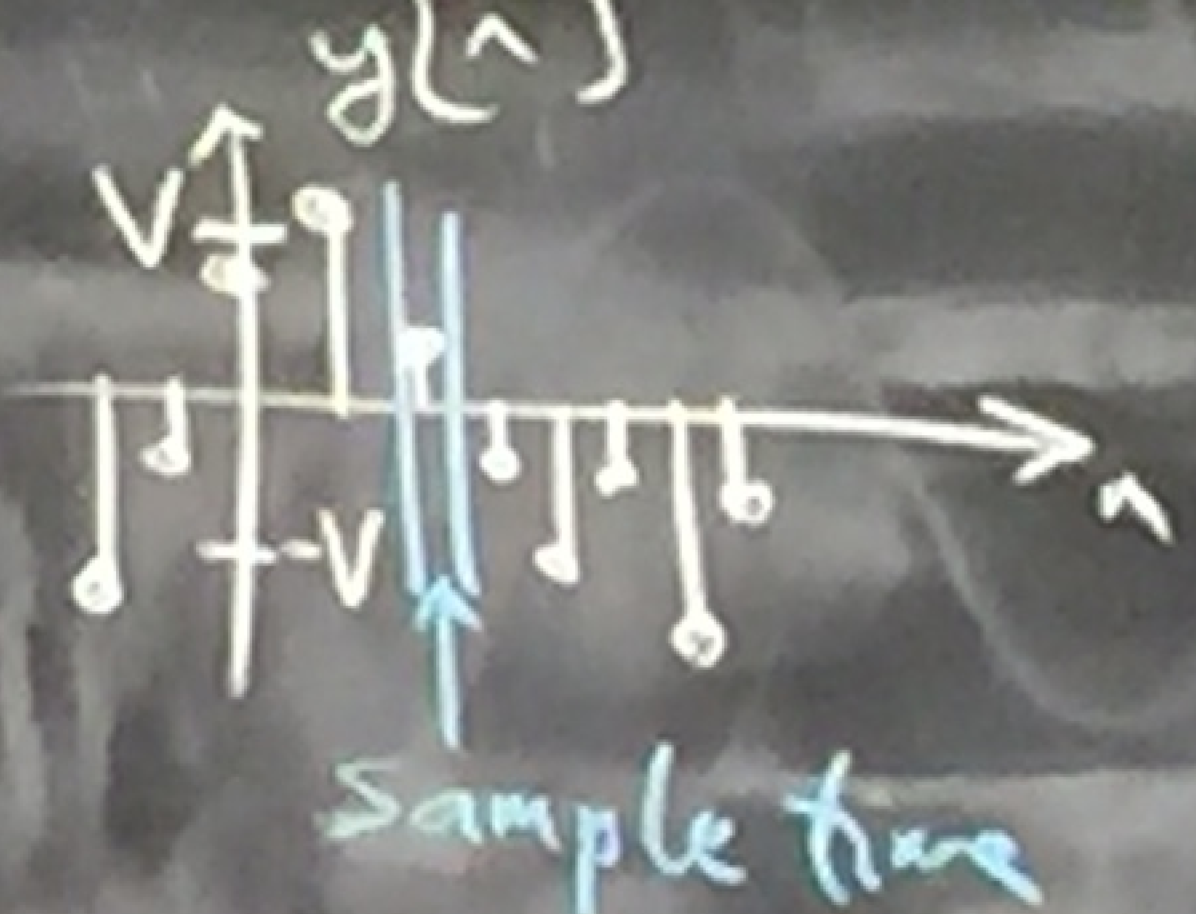
(Bit flip prob p)

Signals

Bits

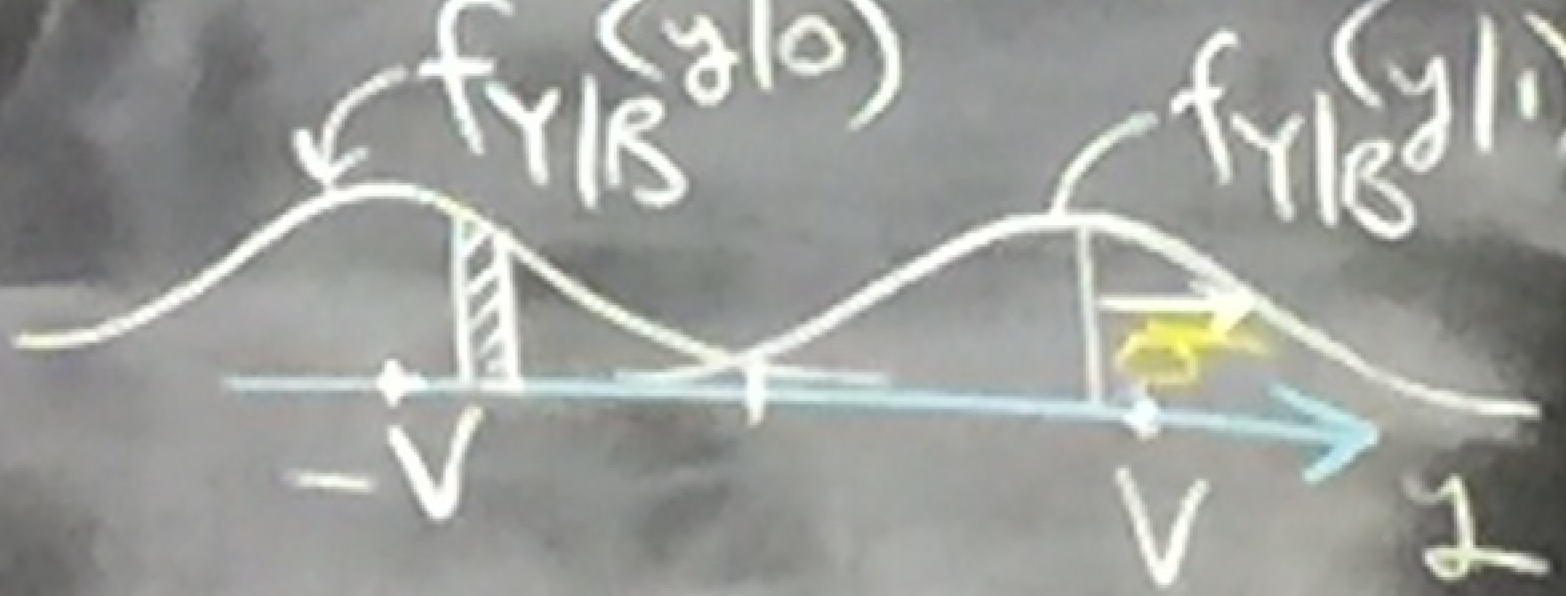
Signals


Bits
0110
'Digitizer'
Signals
x[n]
n
Baseband channel
Noise
y[n]
representation of x[n]

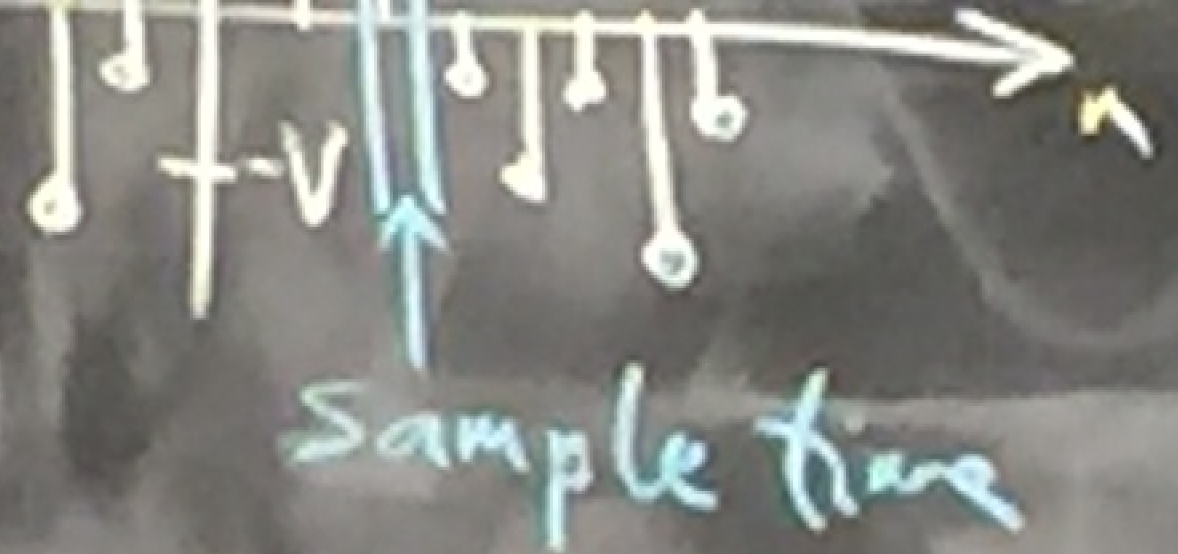


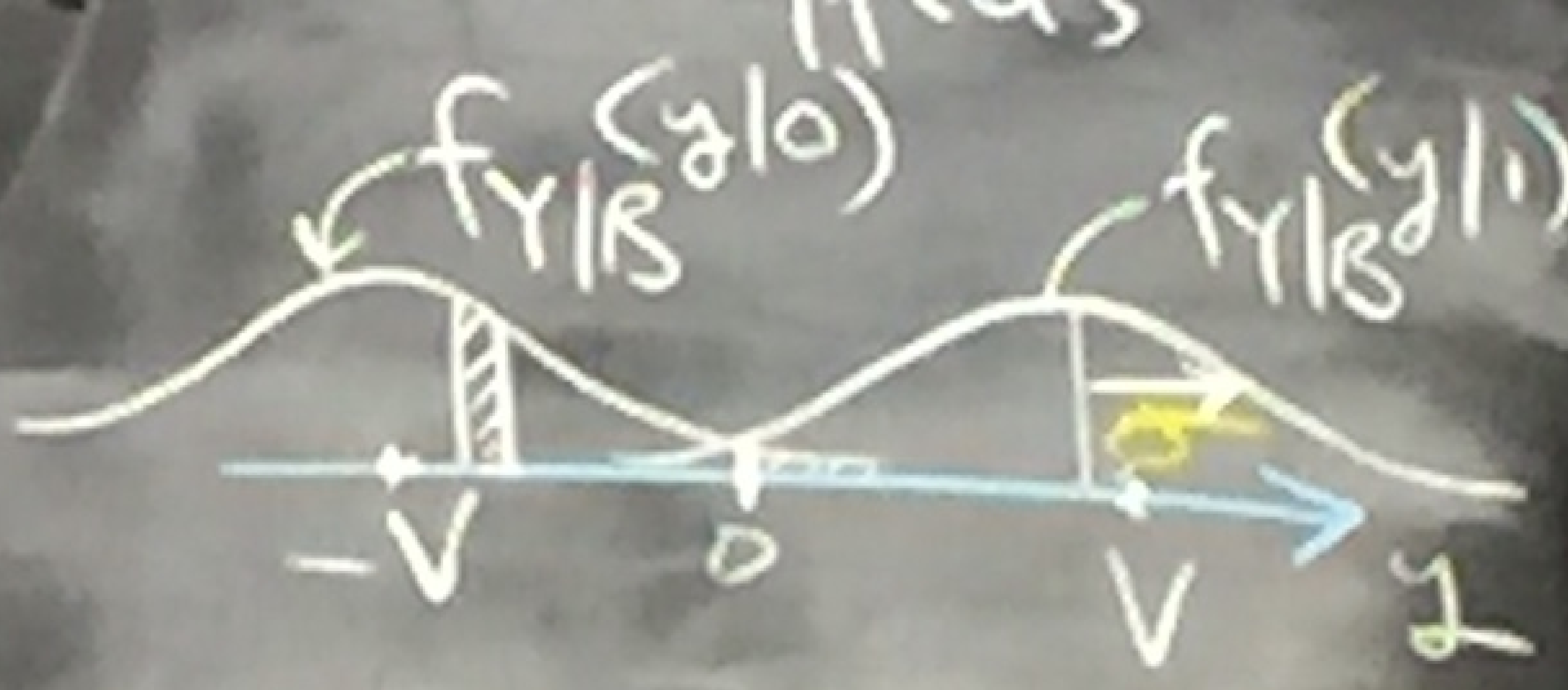
Assume no distortion

Noise effects



Bit





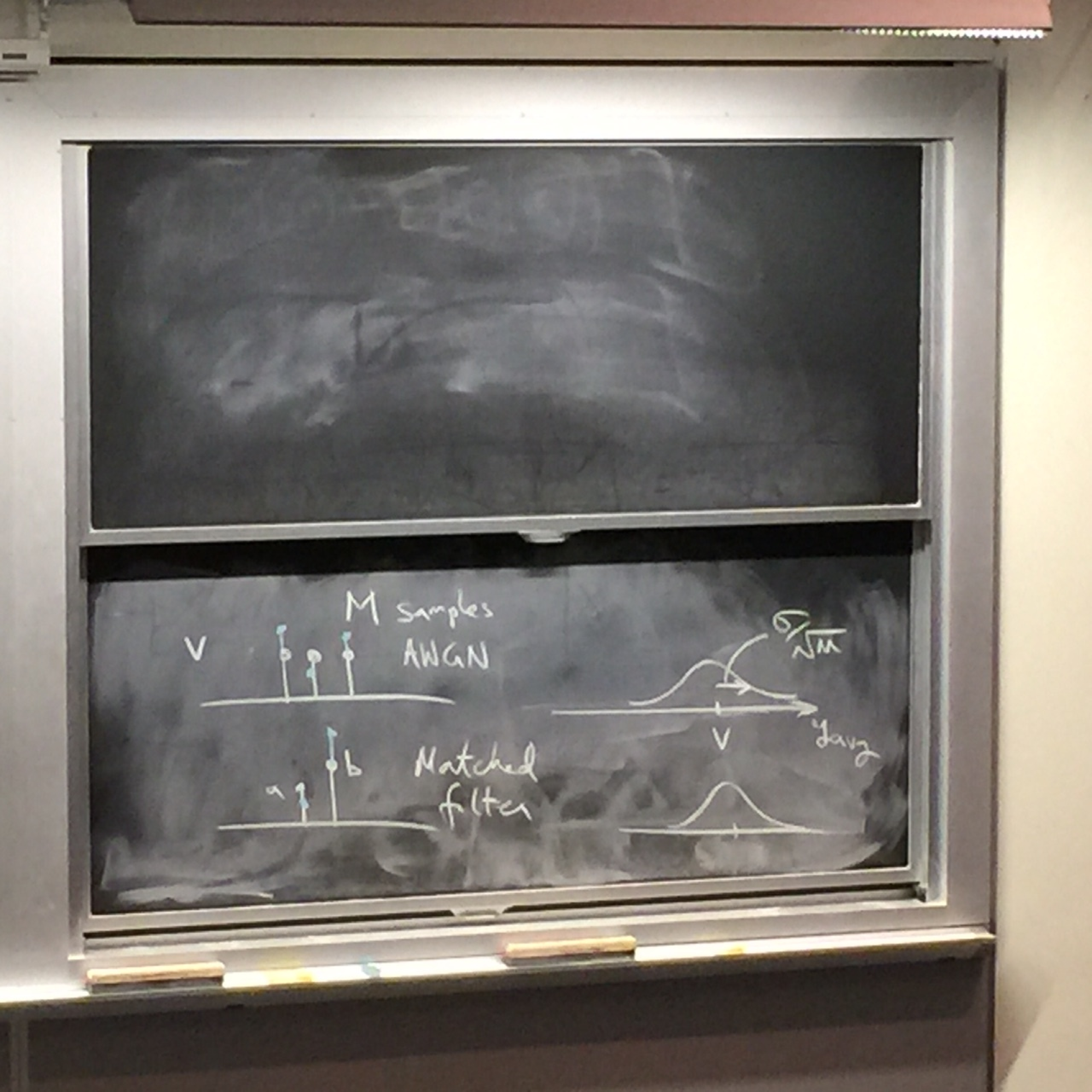
Bit flip prob p : $Q\left(\frac{V}{\sigma}\right)$

Prob of error : $\underbrace{P(B=0)\,P(\text{`1'}\,|\,0)} + \underbrace{P(B=1)\,P(\text{`0'}\,|\,1)}$

If 0 and 1 are equally likely

$P_{err} = Q\left(\frac{V}{\sigma}\right)$ bipolar

$Q\left(\frac{V}{2\sigma}\right)$ on-off

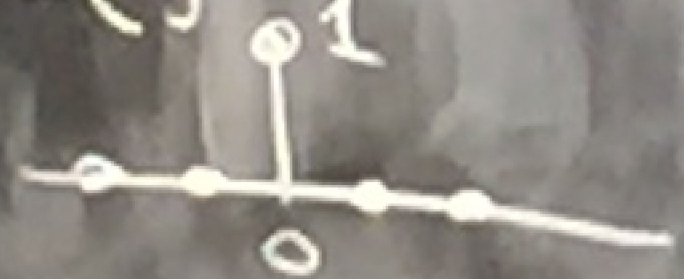

M samples
V
AWGN
σ/√M
V
y_avg
b
a
Matched filter

$$x[n] \longrightarrow \boxed{\text{Baseband}} \longrightarrow y[n]$$

LTI model: $y[n] = \sum_{k} x[k]\,h[n-k]$

where $h[\cdot]$ is the unit sample response

$\delta[n]$



Given: $x_1[n] \rightarrow \boxed{h[\cdot]} \rightarrow 0$ for all n

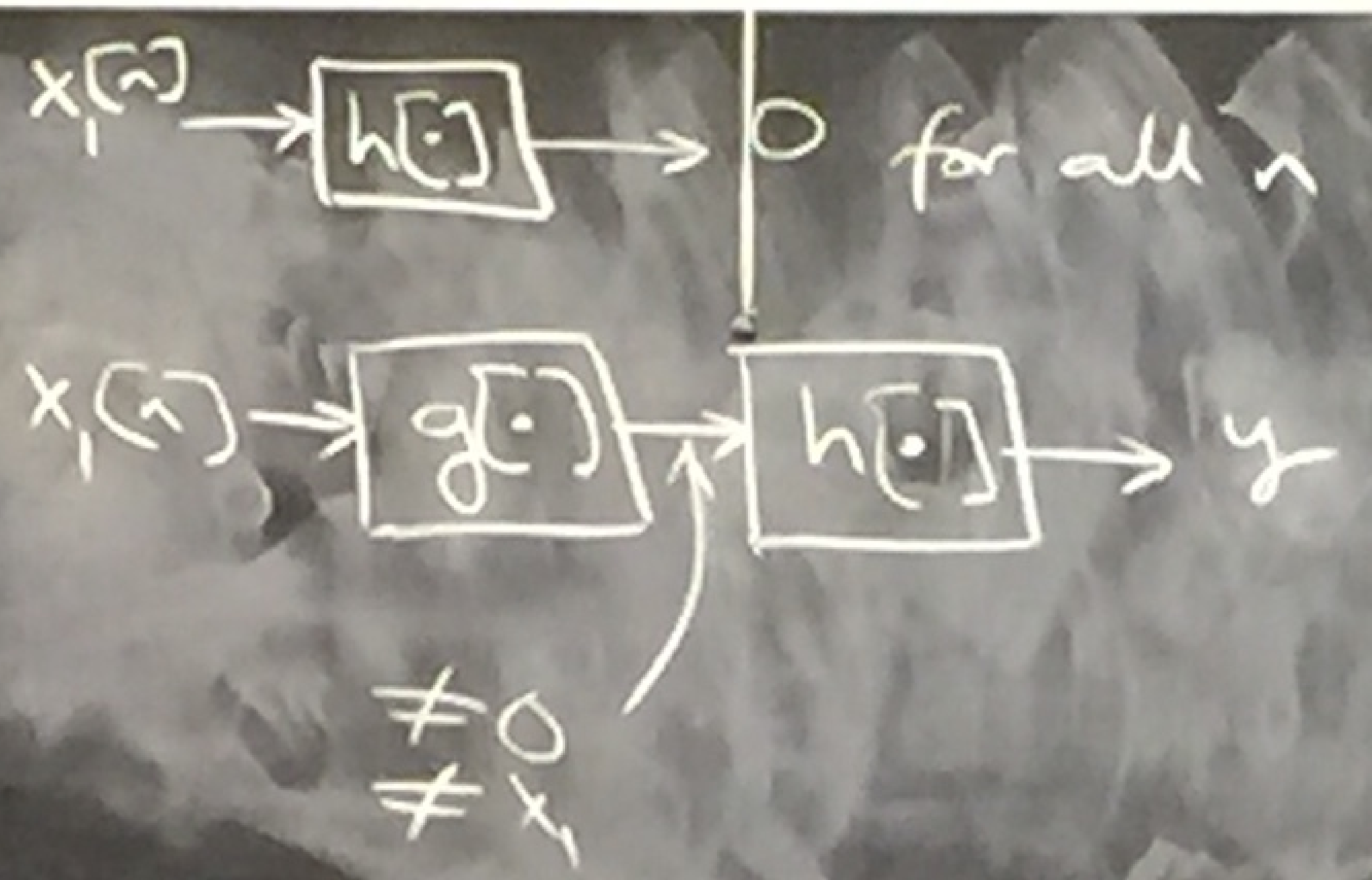
$x_1[n] \rightarrow \boxed{g[\cdot]} \rightarrow \boxed{h[\cdot]} \rightarrow y$

$\neq 0$

$\neq x_1$

$$y = h * (g * x_1)$$
$$= (h * g) * x_1$$

Given:

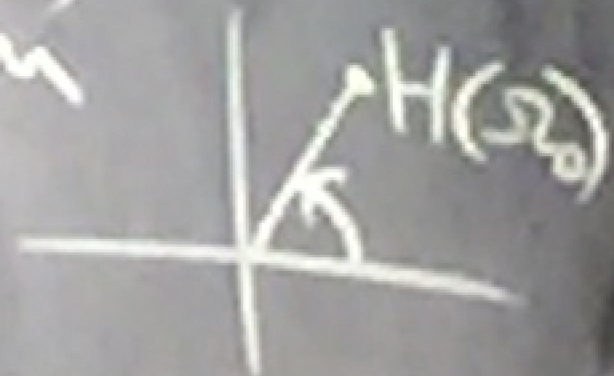


$$
\begin{aligned}
y &= h*(g*x_1) \\
&= (h*g)*x_1 \\
&= (g*h)*x_1 = g*(\cancelto{0}{h*x_1})
\end{aligned}
$$

Sinusoidal inputs $A_0 \cos(\Omega_0 n + \theta_0) = x[n]$

Freq. resp $\quad H(\Omega) = \sum_m h[m] e^{-j\Omega m}$

DTFT



$$y[n] = |H(\Omega_0)| A_0 \cos(\Omega_0 n + \theta_0 + \angle H(\Omega_0))$$

Filter design: moving average filters

ideal low pass filters

se FT $\quad h[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} H(\Omega) e^{j\Omega n} \, d\Omega$

$$y[n] = |H(\Omega_0)| A\cos(\Omega_0 n + \theta_0 + \angle H(\Omega_0))$$

Filter design: moving average filters
ideal lowpass filters

Inverse DTFT
$$h[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} H(\Omega) e^{j\Omega n}\, d\Omega$$

For any signal of interest in 6.02,

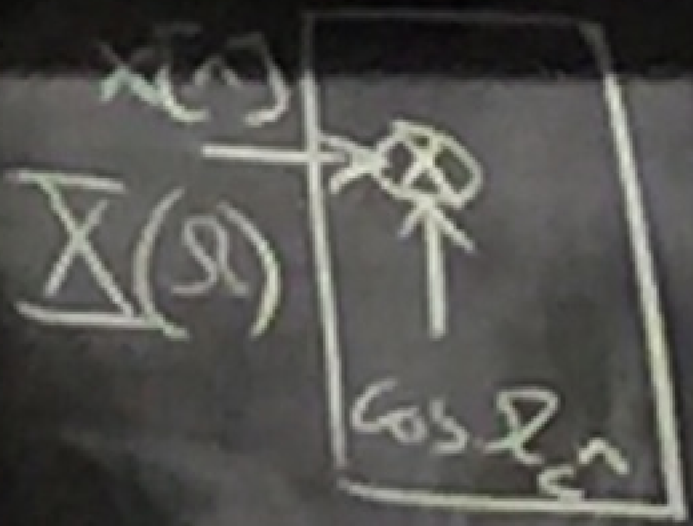
e.g. abs. summ.

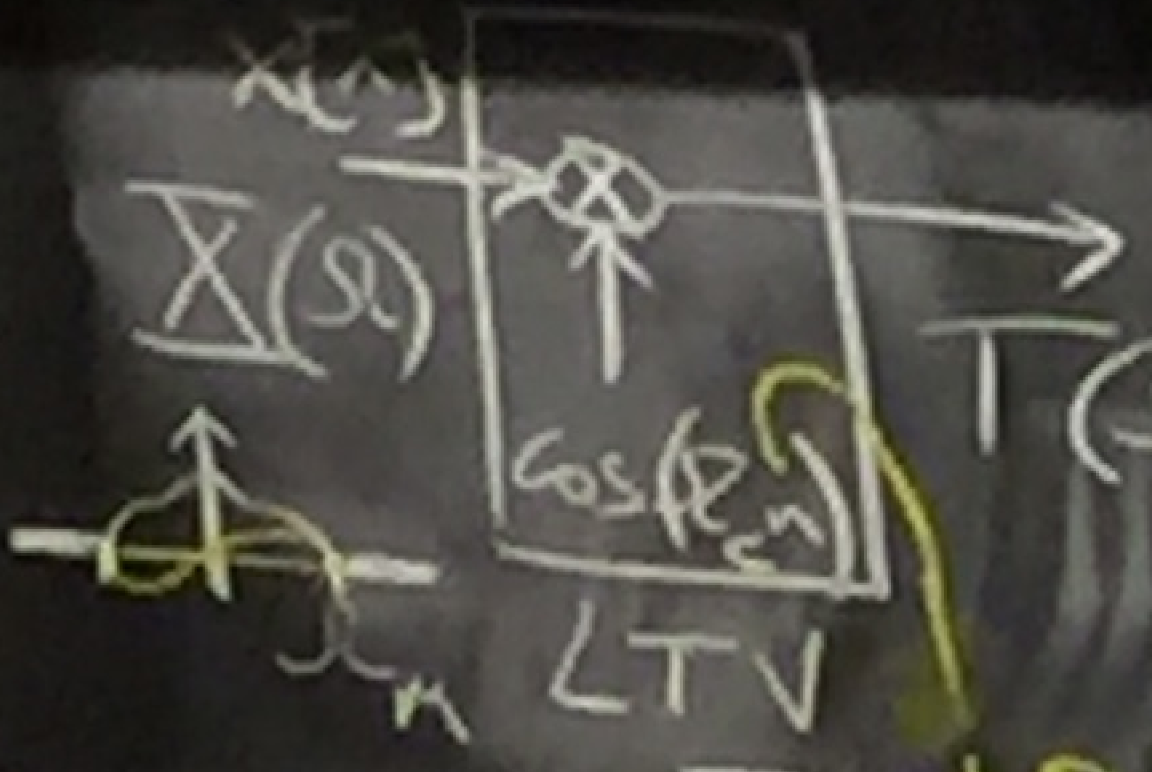
$$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\Omega)\, e^{j\Omega n}\, d\Omega$$

where

$$X(\Omega) = \sum_{m} x[m]\, e^{-j\Omega m}$$

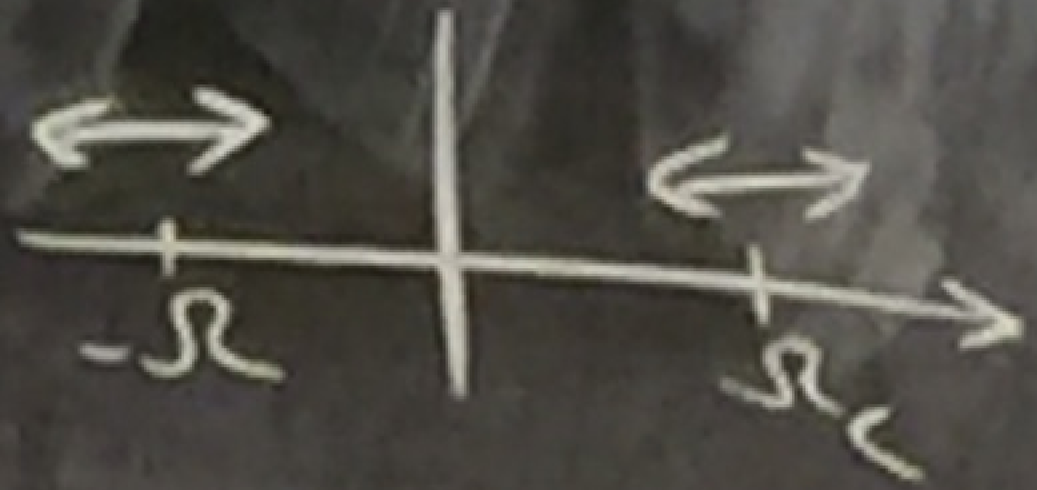
$$\underline{X}(\Omega) \longrightarrow \underset{H(\Omega)}{\text{LTI}} \longrightarrow Y(\Omega) = H(\Omega)\,\underline{X}(\Omega)$$

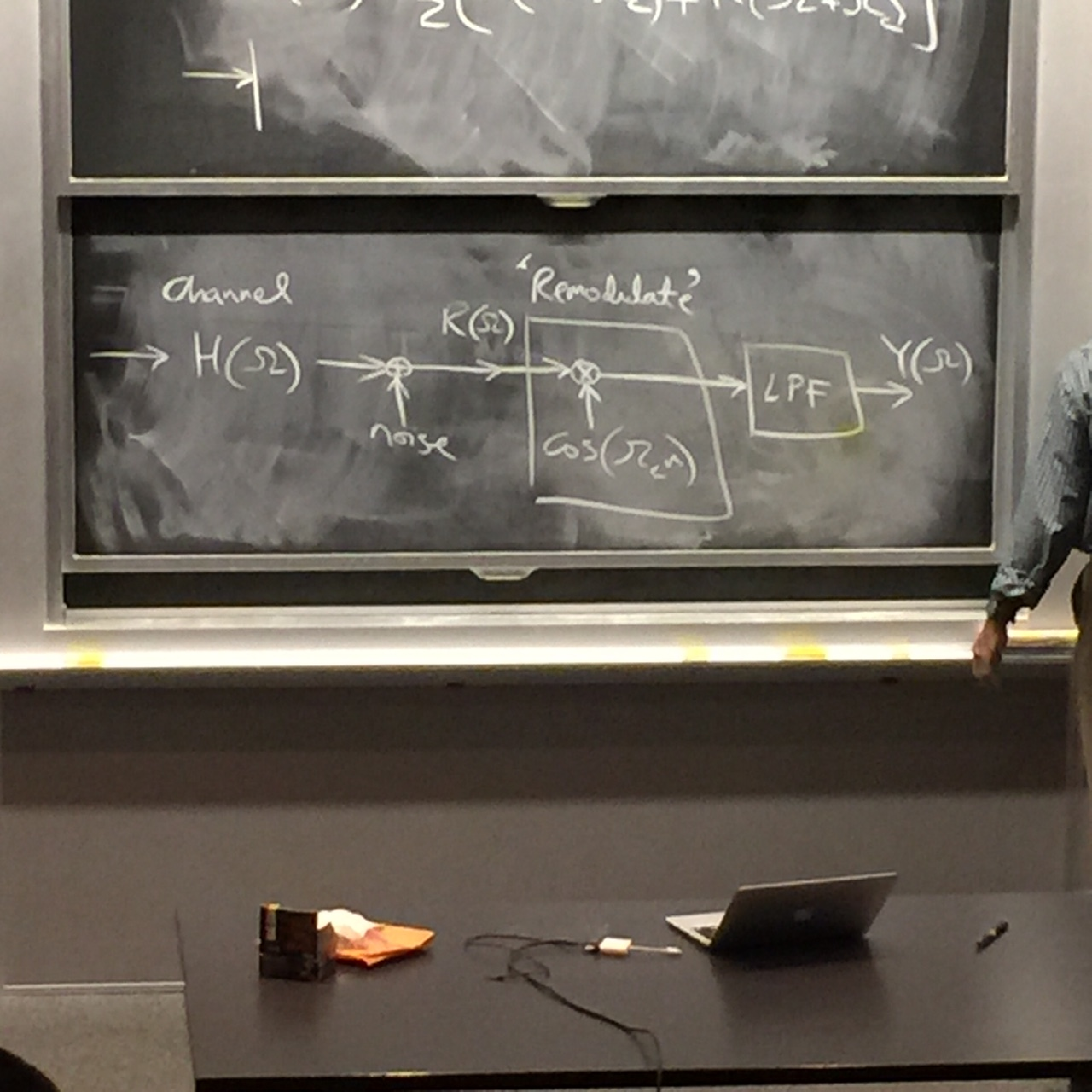




LTV
=
Modulator

$$T(\Omega) = \frac{1}{2}\left[\overset{e^{j\theta}}{X(\Omega-\Omega_c)} + \overset{e^{-j\theta}}{X(\Omega+\Omega_c)} \right]$$

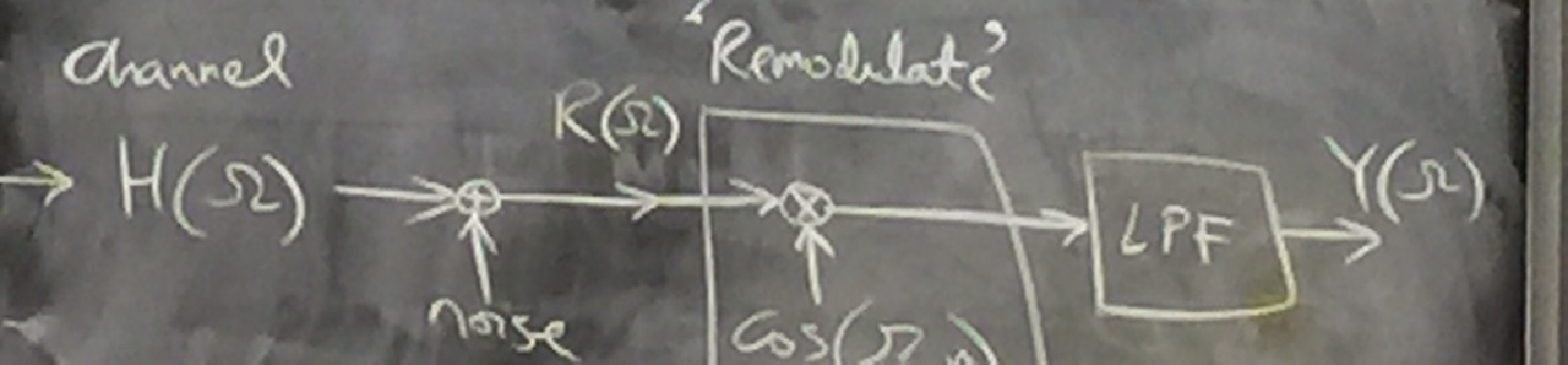




Channel
H(Ω)
R(Ω)
noise
'Remodulate'
cos(Ω_c n)
LPF
Y(Ω)

If channel freq resp = 1 in carrier freq. range (no distortion)

$$W(\Omega) = \frac{1}{2}\left[R(\Omega-\Omega_c) + R(\Omega+\Omega_c)\right]$$

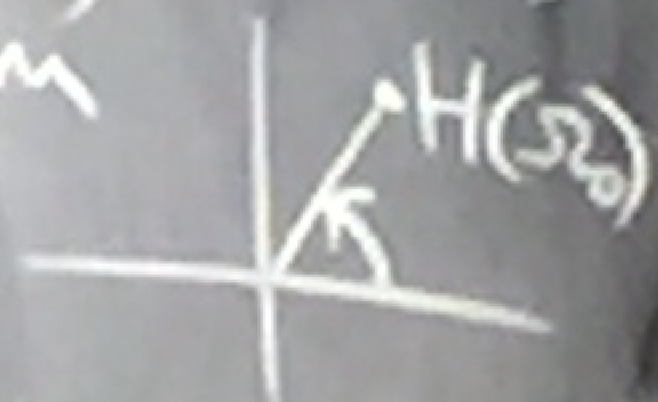


sinusoidal inputs $A_0\cos(\Omega_0 n + \theta_0) = x[n]$

Freq. resp

$$H(\Omega) = \sum_m h[m]\, e^{-j\Omega m}$$

DTFT



$$y[n] = |H(\Omega_0)|\, A_0 \cos\left(\Omega_0 n + \theta_0 + \angle H(\Omega_0)\right)$$

$$(\Omega) \rightarrow \boxed{\frac{1}{2}\left[H(\Omega-\Omega_c) + H(\Omega+\Omega_c)\right]} \rightarrow Y(\Omega)$$

Baseband