Recovering transmitted data

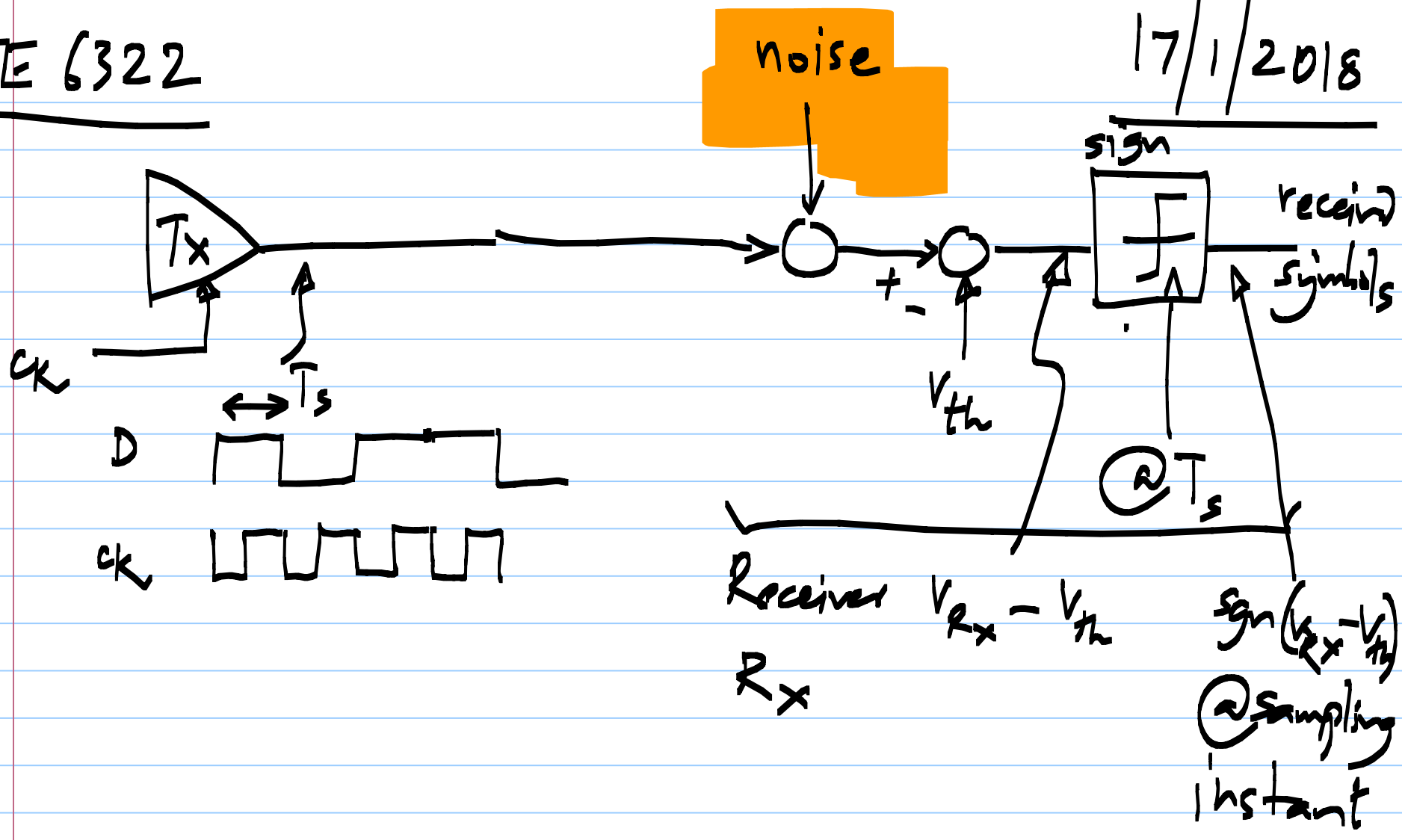
— Restoring the waveform

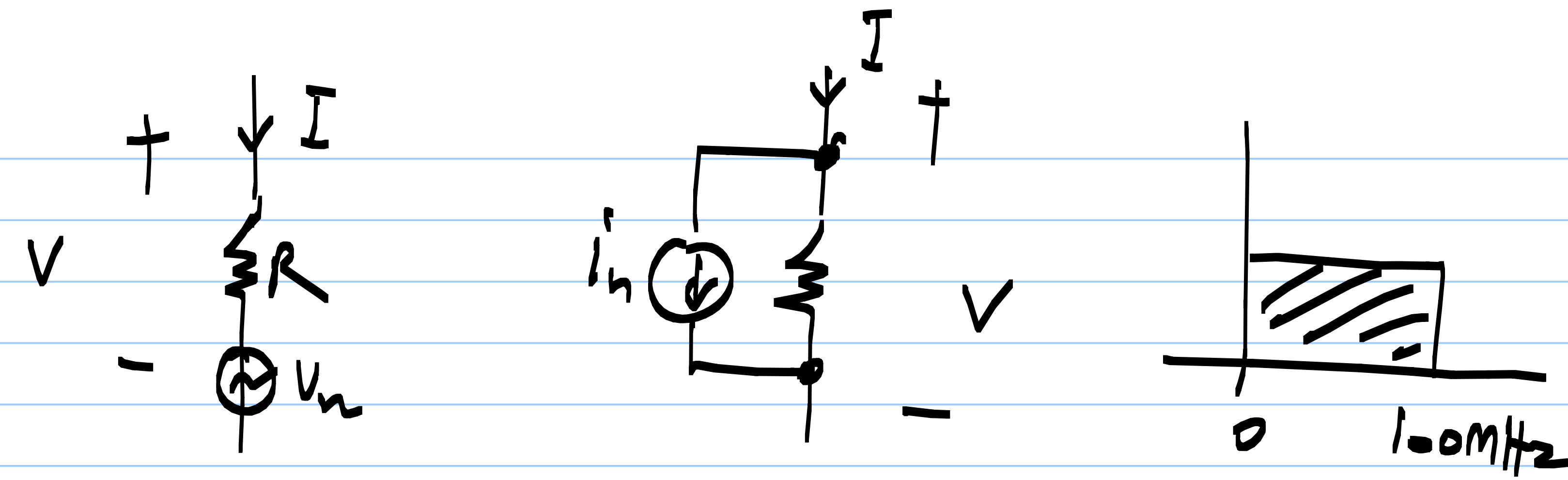
Equalization

Clock & data recovery — Recovering the data (recover the clock aligned to data)

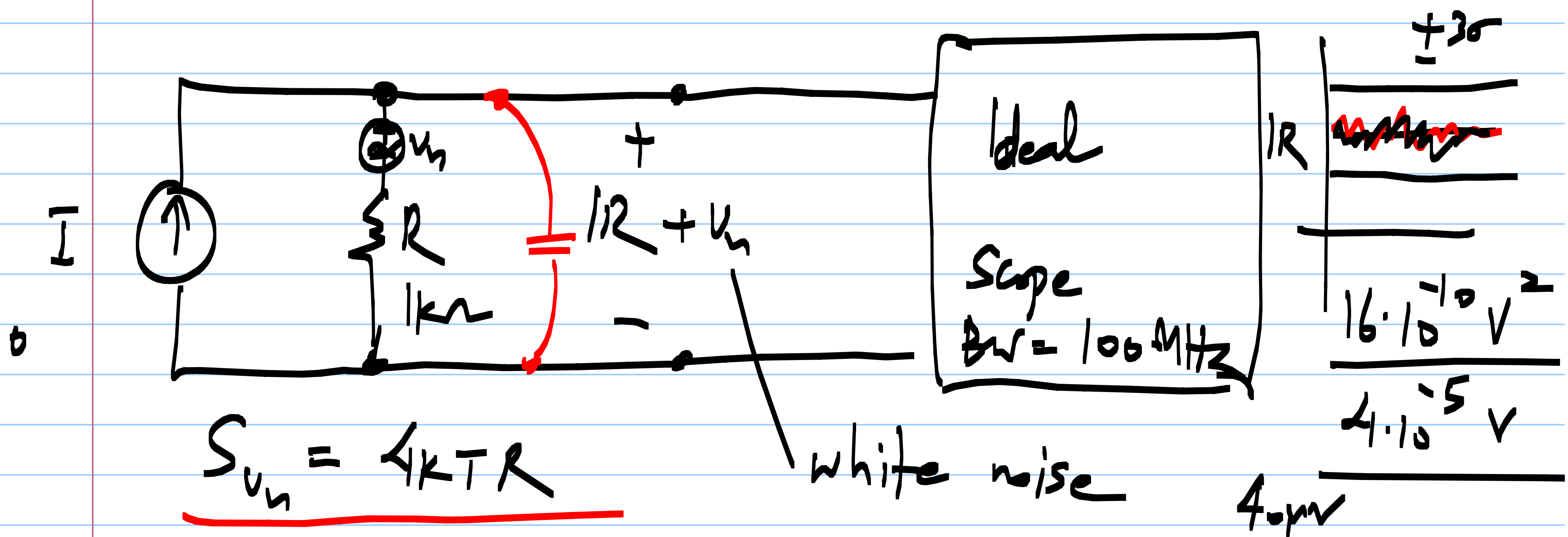
EE 6322

17/1/2018



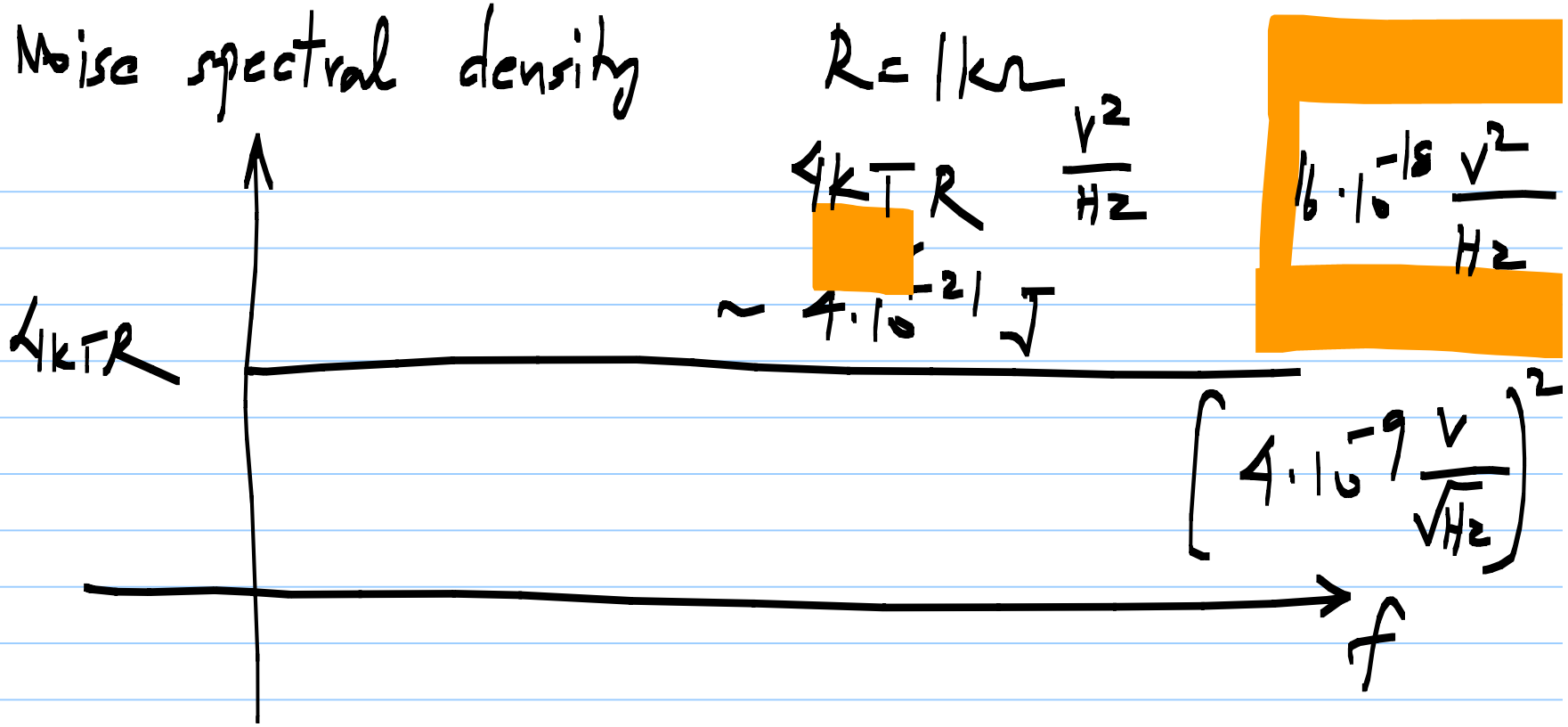


I
+
V
R
−
v_n
I
+
i_n
V
−
0
100MHz



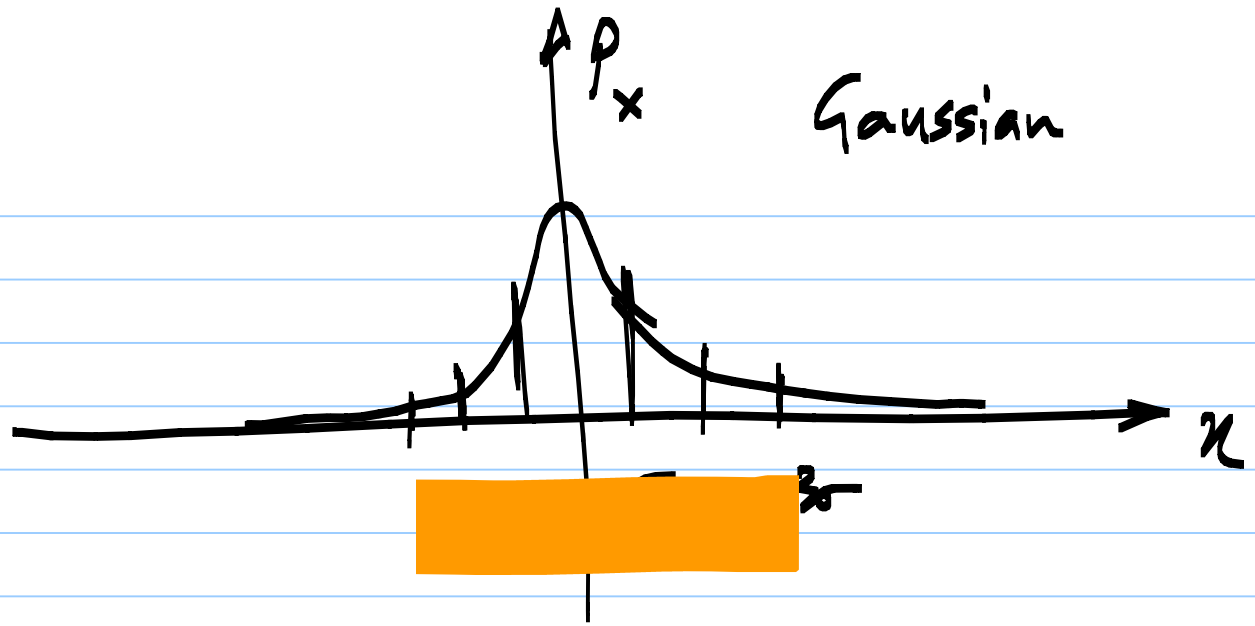
I
v_n
R
1kΩ
+
IR + v_n
−
white noise
Ideal
Scope
BW = 100MHz
IR
±3σ
$16 \cdot 10^{-10}\ V^2$
$4 \cdot 10^{-5}\ V$
40μV

$S_{v_n} = 4kTR$



4kTR: single sided spectral density

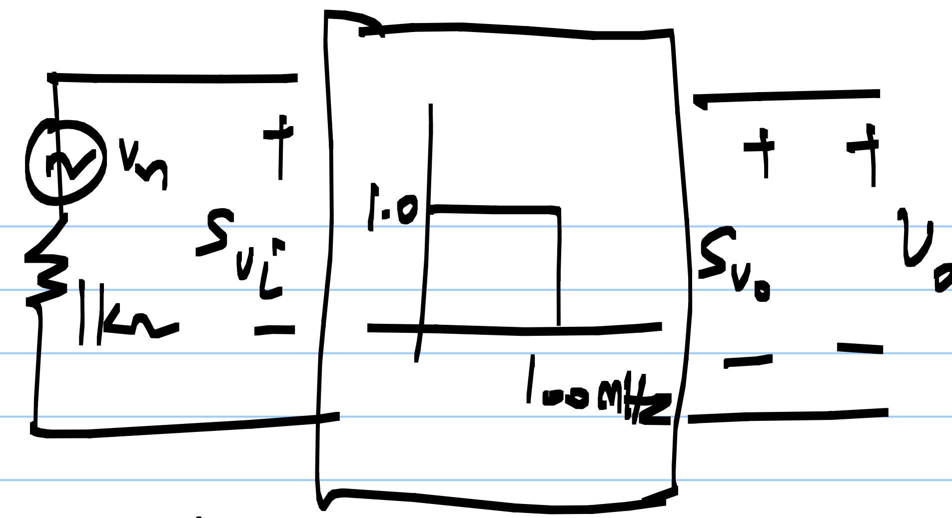
$0 \leq f \leq \infty$



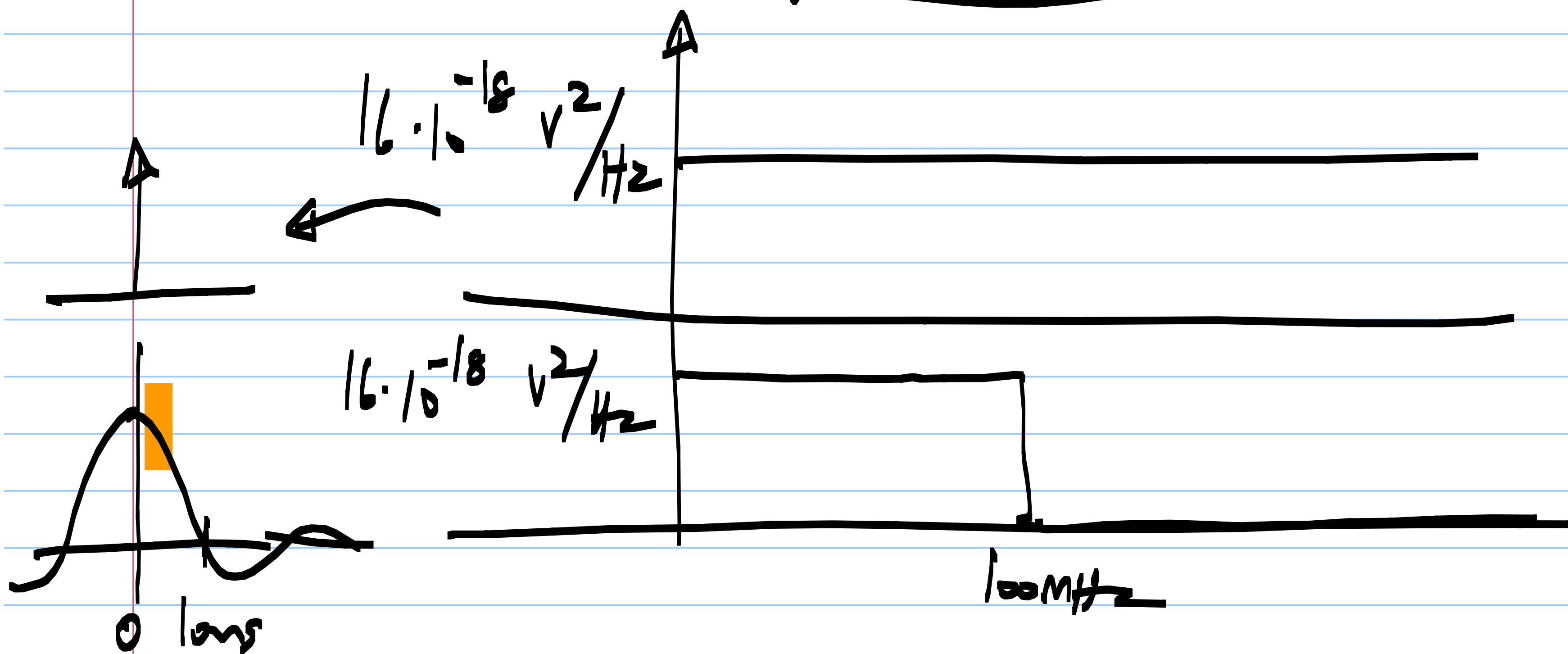
$$p_x = \frac{1}{\sqrt{2\pi}\cdot\sigma}\cdot\exp\left(-\frac{x^2}{2\sigma^2}\right)$$

standard deviation

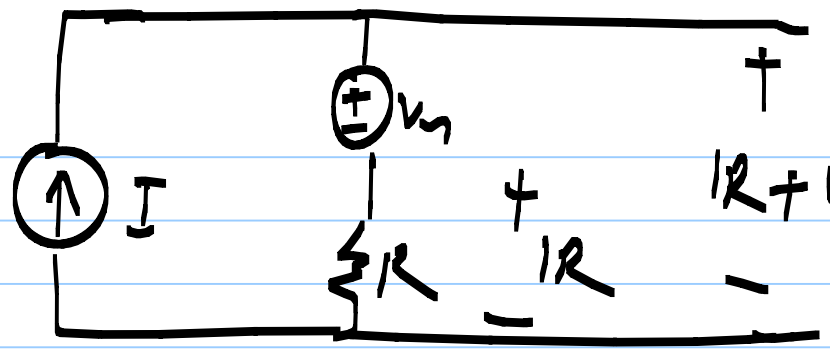
$$S_{v_i} |H(f)|^2 = S_{v_o}$$



v_n
1kΩ
+
S_{v_i}
−
1.0
100MHz
+
S_{v_o}
−
+
v_o
−



$16 \cdot 10^{-18}$ V^2/Hz
$16 \cdot 10^{-18}$ V^2/Hz
100MHz
0
10ns



$\sqrt{100\,MHz} = 10^4 \sqrt{Hz}$

spectral density = $4kTR$ V^2/Hz

Bandlimiting (B)

Variance : $4kTR \cdot B$

: $\sqrt{4kTR \cdot B}$

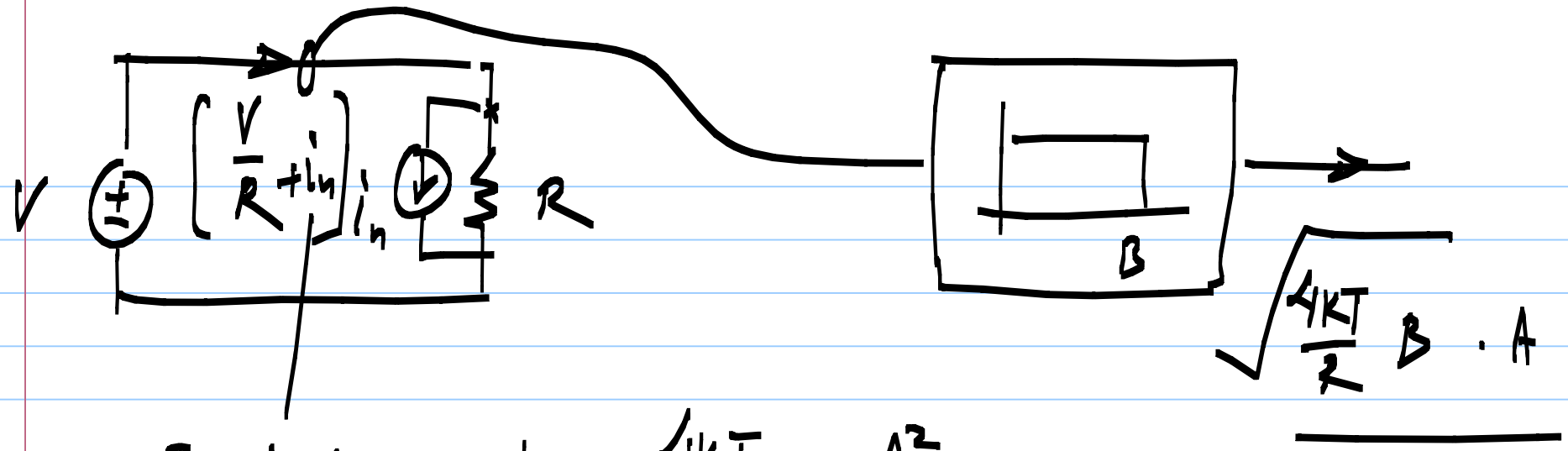
$kT : 4 \cdot 10^{-21}\ J$

@ RT

$1k\Omega$: $4kTR = 16 \cdot 10^{-18}\ V^2/Hz$

$4nV/\sqrt{Hz}$ $\quad 4 \cdot 10^{-9}\ V/\sqrt{Hz}$

0.4mV $\quad 4 \cdot 10^{-5}\ V$



spectral density: $\frac{4KT}{R} \cdot \frac{A^2}{Hz}$