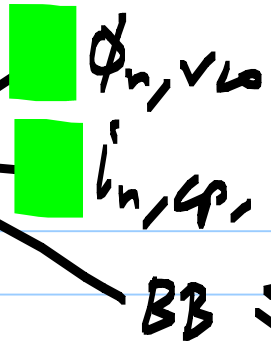
JTOL, JTRAN; JGEN



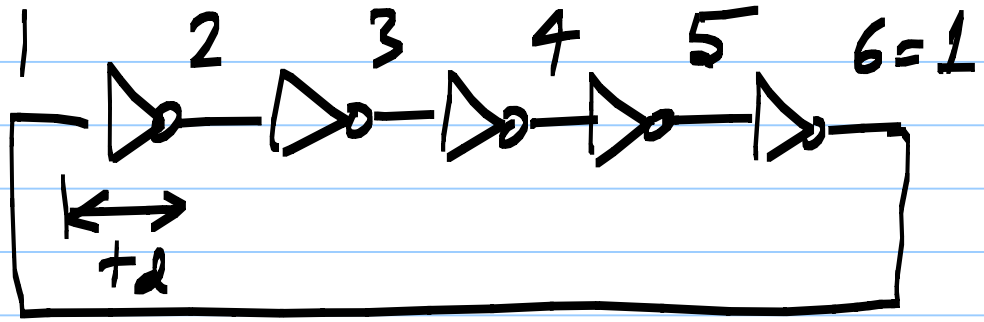
} Pulsing nature of the PD

Phase noise of a VCO: Thermal noise of the components

- LC VCO
- Ring VCO

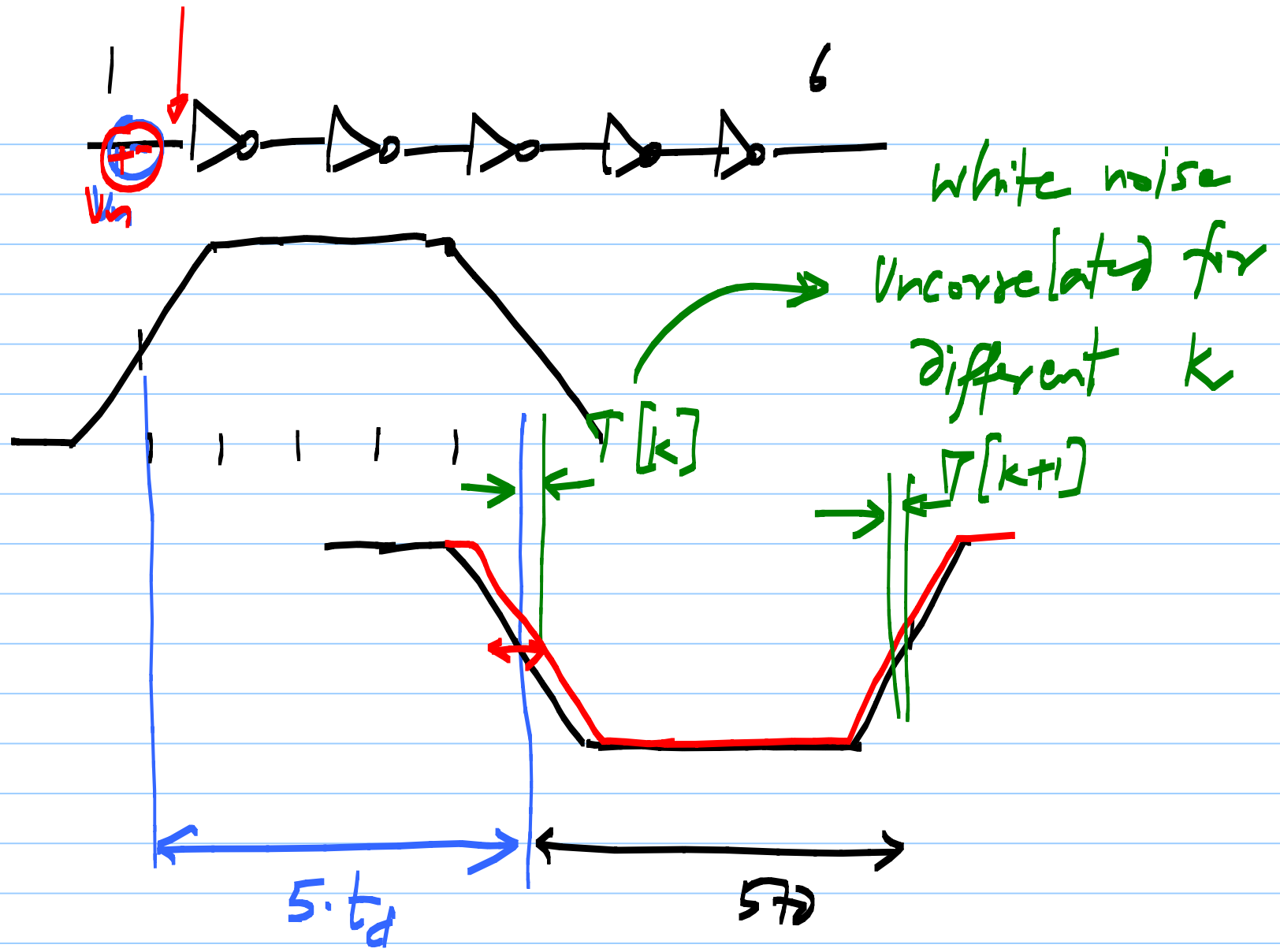
Ring oscillator:

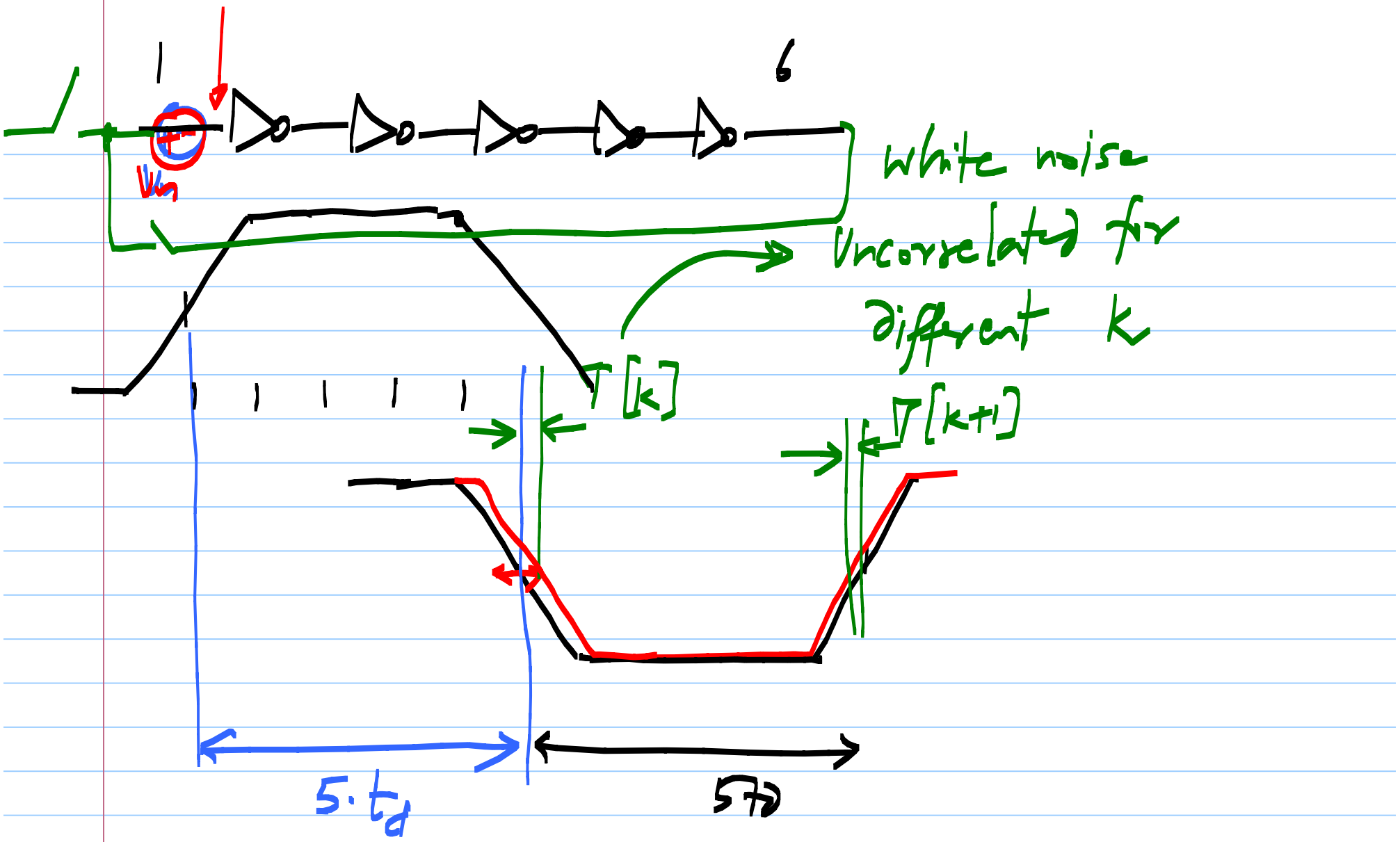
N inverters



$$\text{period} = 2N \cdot t_d$$

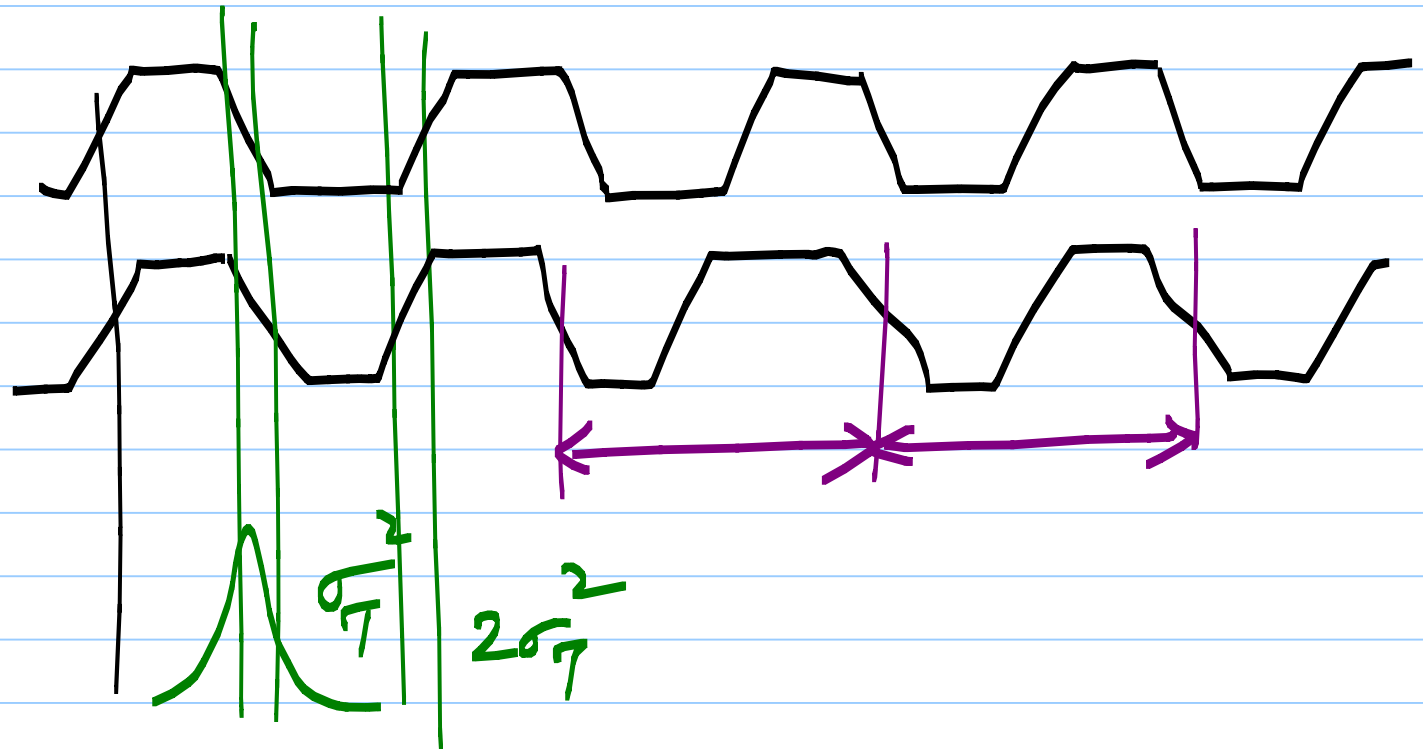
$$f_0 = \frac{1}{2N \cdot t_d}$$

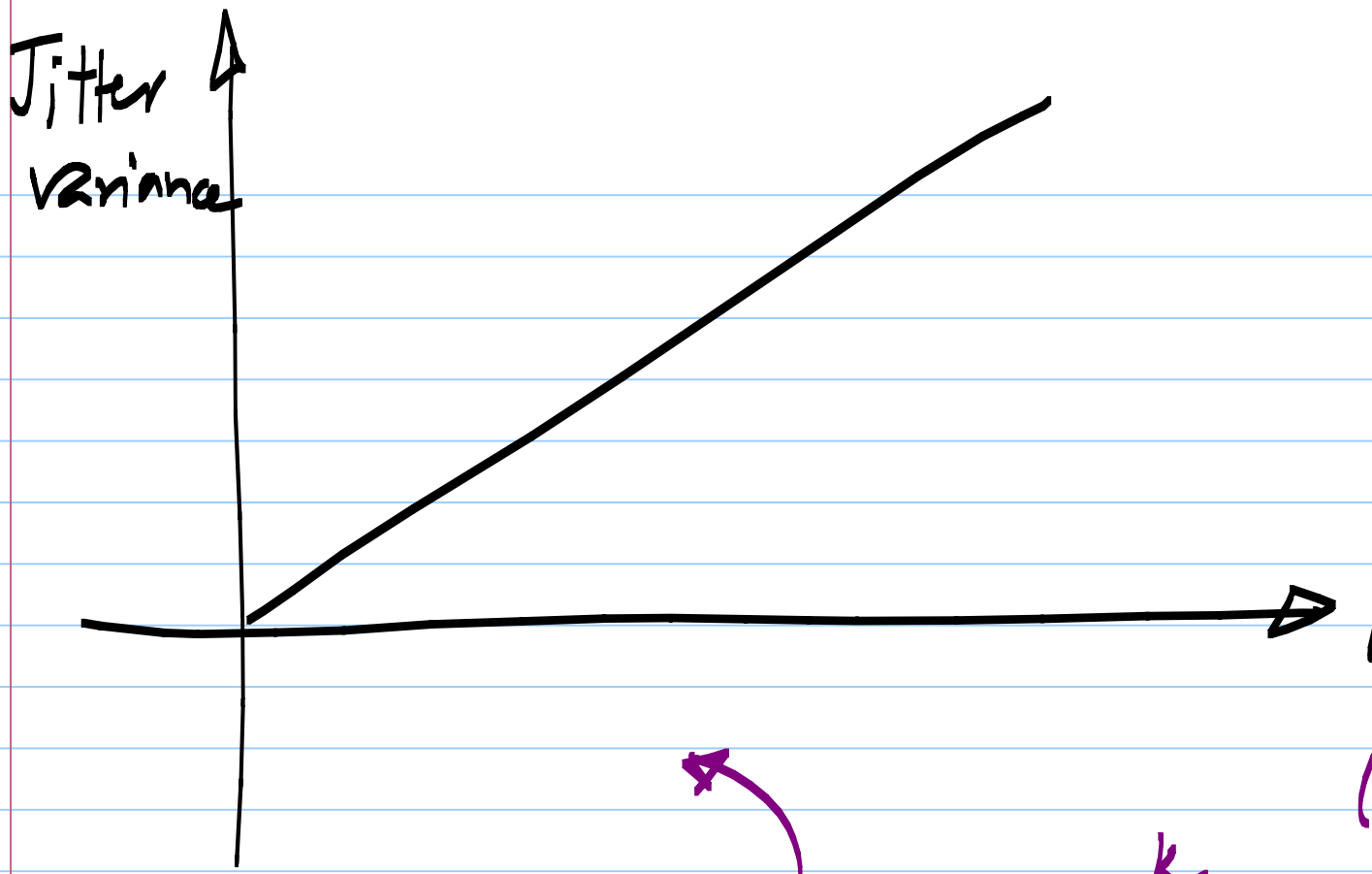

1
6
V_{in}
white noise
Uncorrelated for
different k
$\tau[k]$
$\tau[k+1]$
$5 \cdot t_d$
5τ


1
6
V_{in}
white noise
Uncorrelated for
different k
$T[k]$
$T[k+1]$
$5 \cdot t_d$
$5 \cdot t_d$

Oscillator: Autonomous system:

* Assume that the first edge is at the ideal location





white

Absolute jitter $T_{abs}[k] = \sum_{1}^{k} T_d[k]$

$\sigma^2_{abs}[k] = k \cdot \sigma^2_{T_d}$

$$T_{abs}[k] - T_{abs}[k-1] = T_d[k]$$

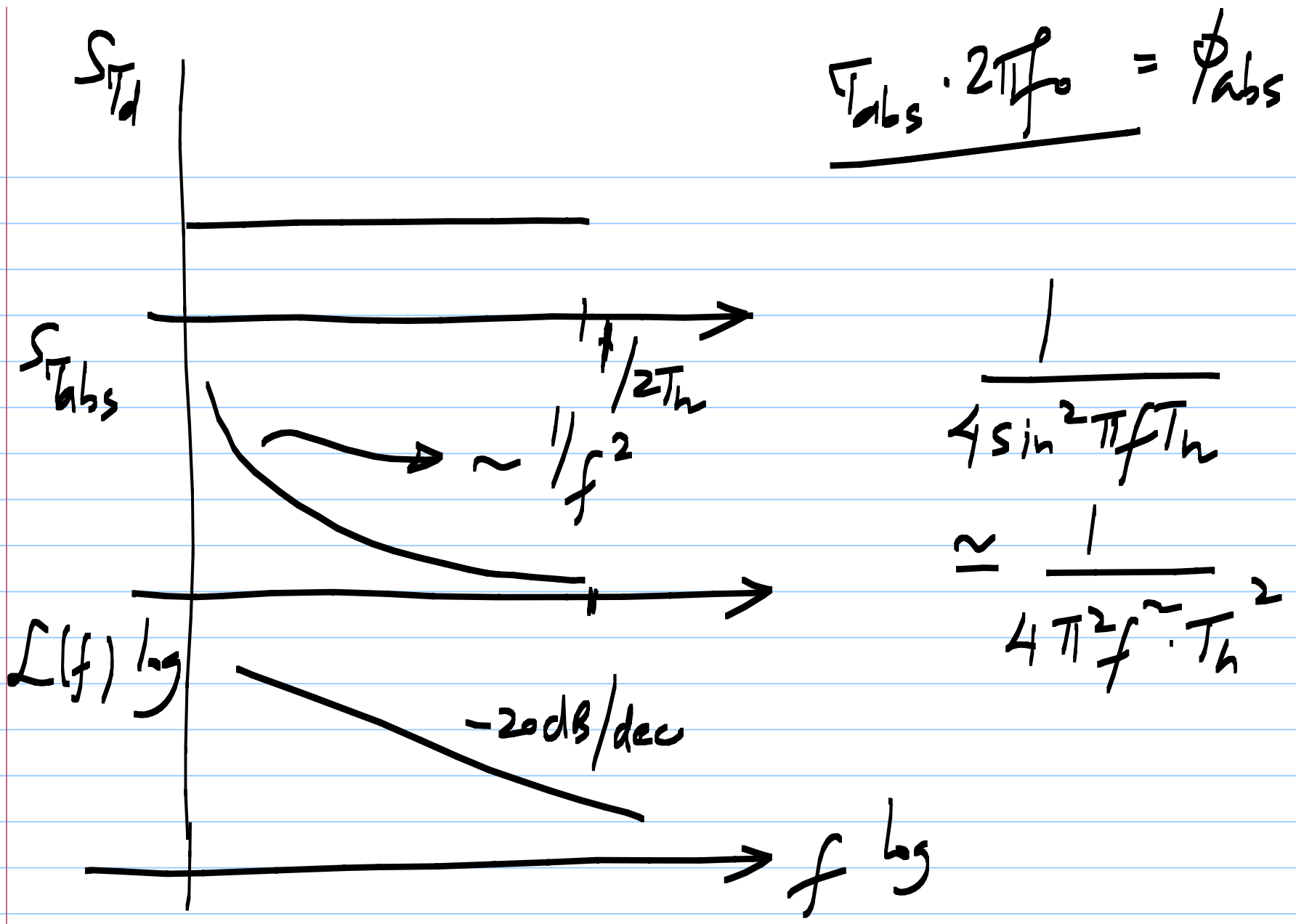
$$T_{abs}(z) = T_d(z) \cdot \frac{1}{1 - z^{-1}}$$

$$S_{T_{abs}}(f) = \underbrace{S_{T_d}(f)}_{\text{white spectrum}} \cdot \left| \frac{1}{\underbrace{1 - \exp(-j 2\pi f T_h)}_{j 2 \sin \pi f T_h}} \right|^2$$

half period

$4 \sin^2 \pi f T_h$

$$\left| \exp(-j \pi f T_h) \right|^2 \cdot \left| \exp(j \pi f T_h) - \exp(-j \pi f T_h) \right|^2$$

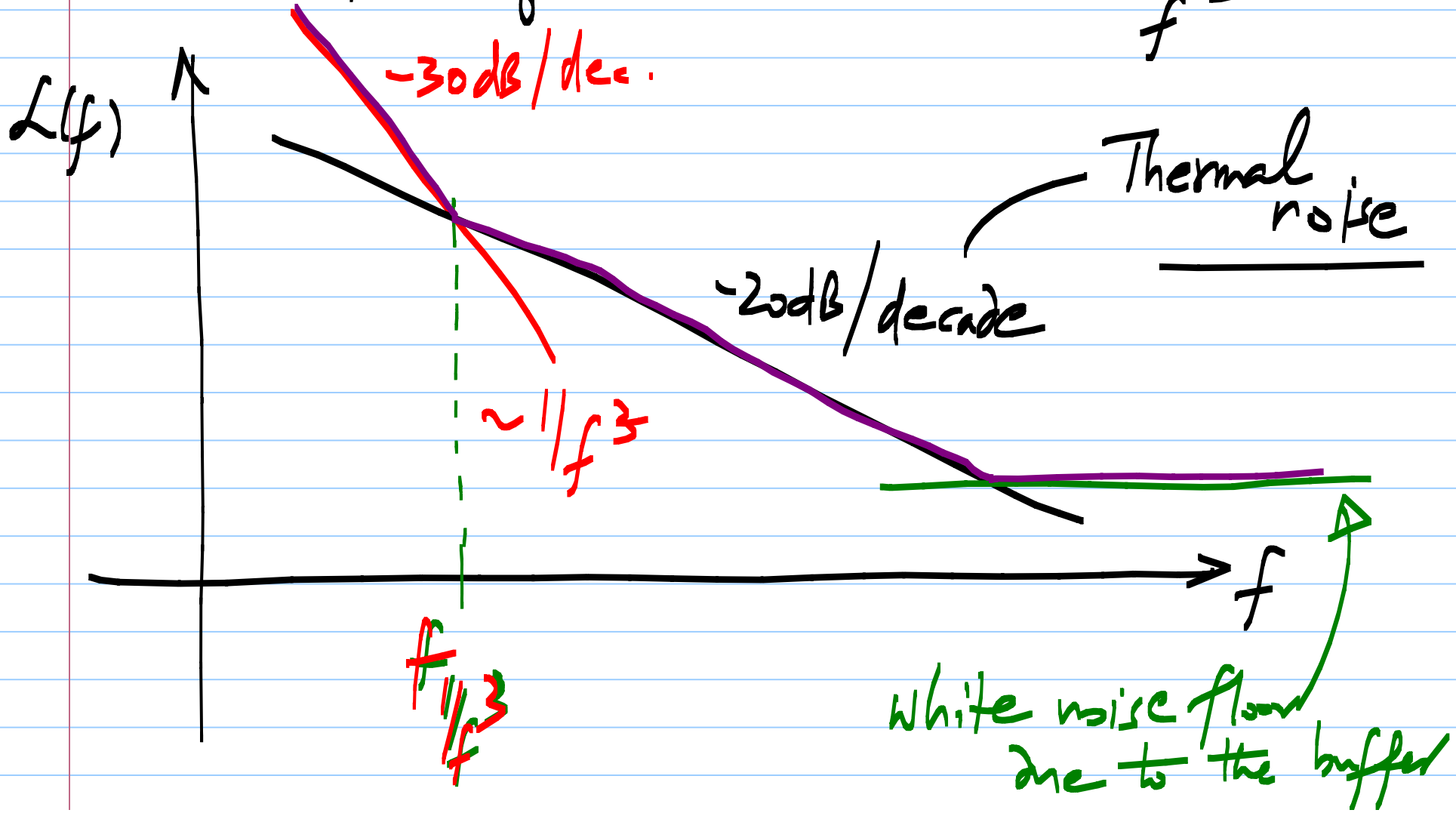


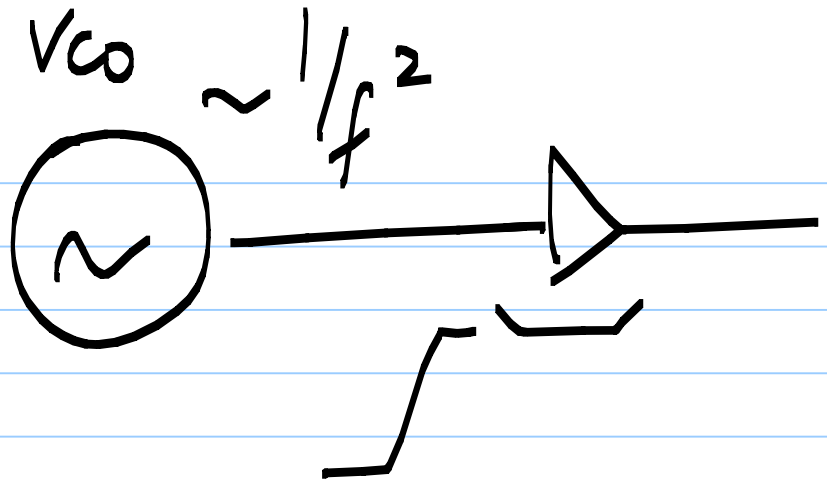
$$\tau_{abs} \cdot 2\pi f_0 = \phi_{abs}$$

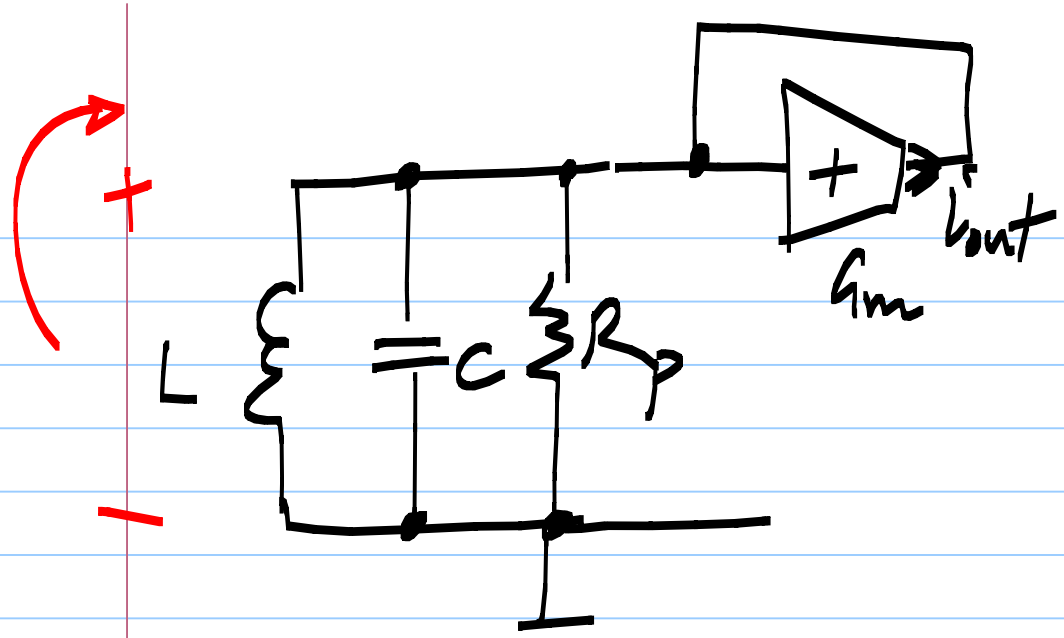
$$\frac{1}{4\sin^2 \pi f T_h}$$

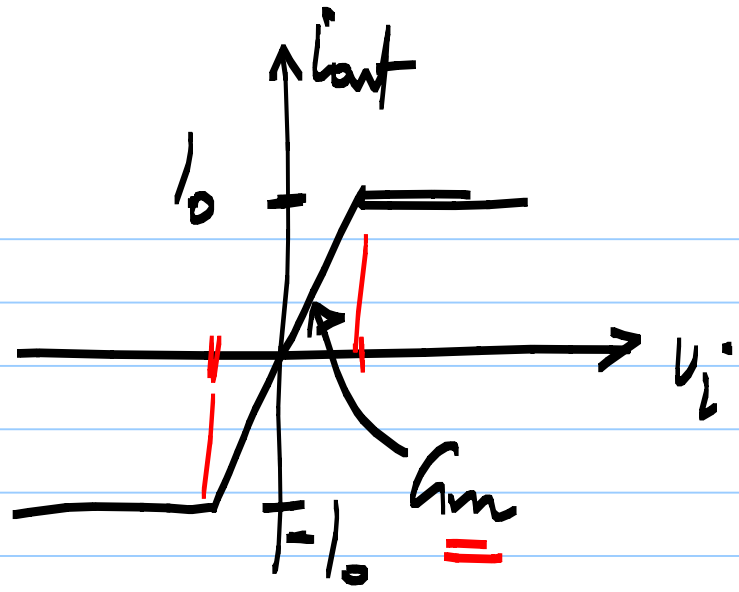
$$\simeq \frac{1}{4\pi^2 f^2 \cdot T_h^2}$$

Phase noise of an oscillator. $\sim \frac{1}{f^2}$

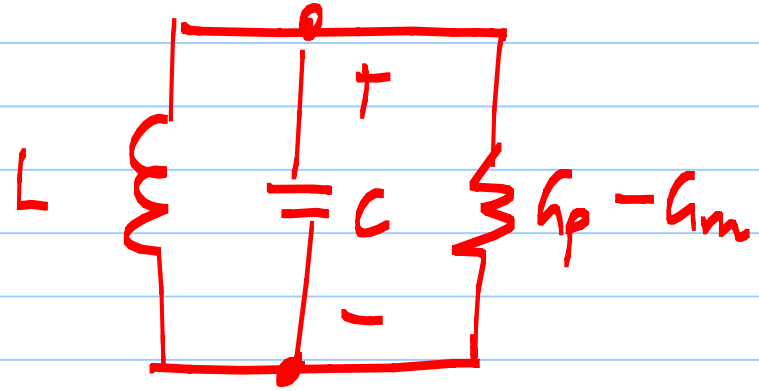


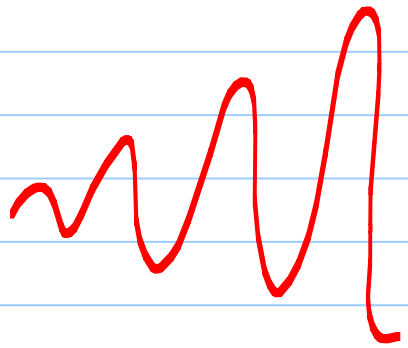

VCO
~ 1/f²

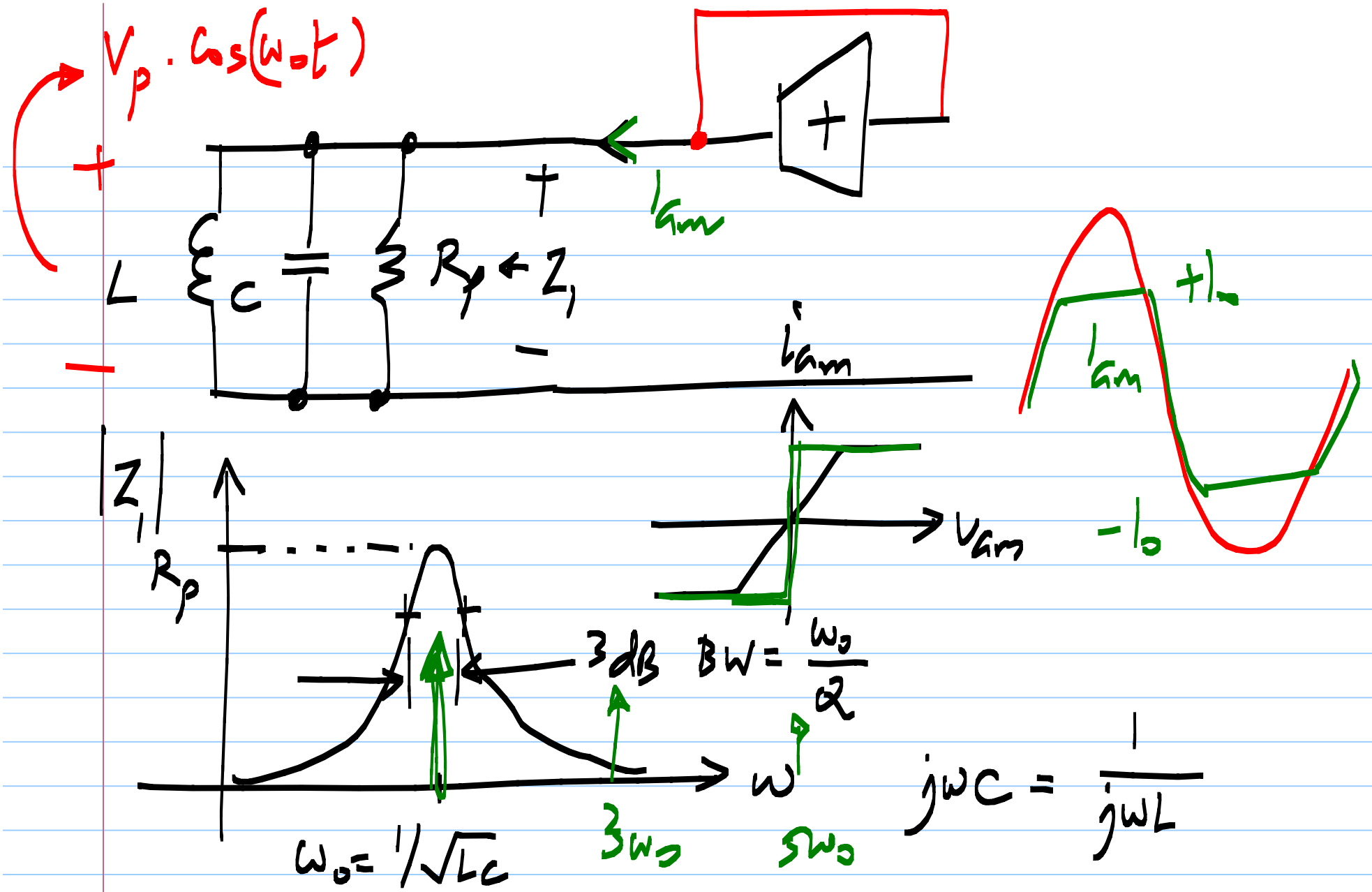


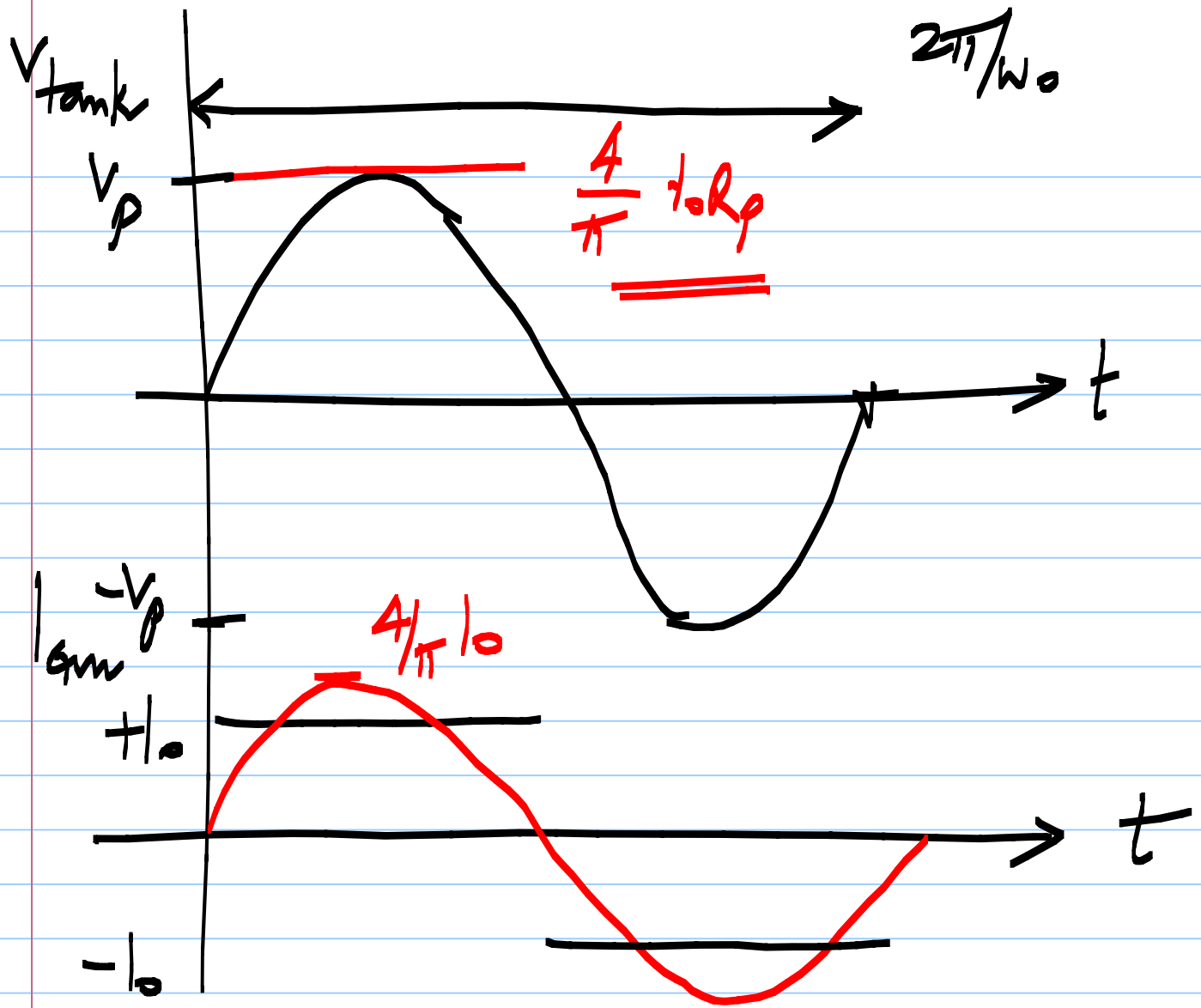


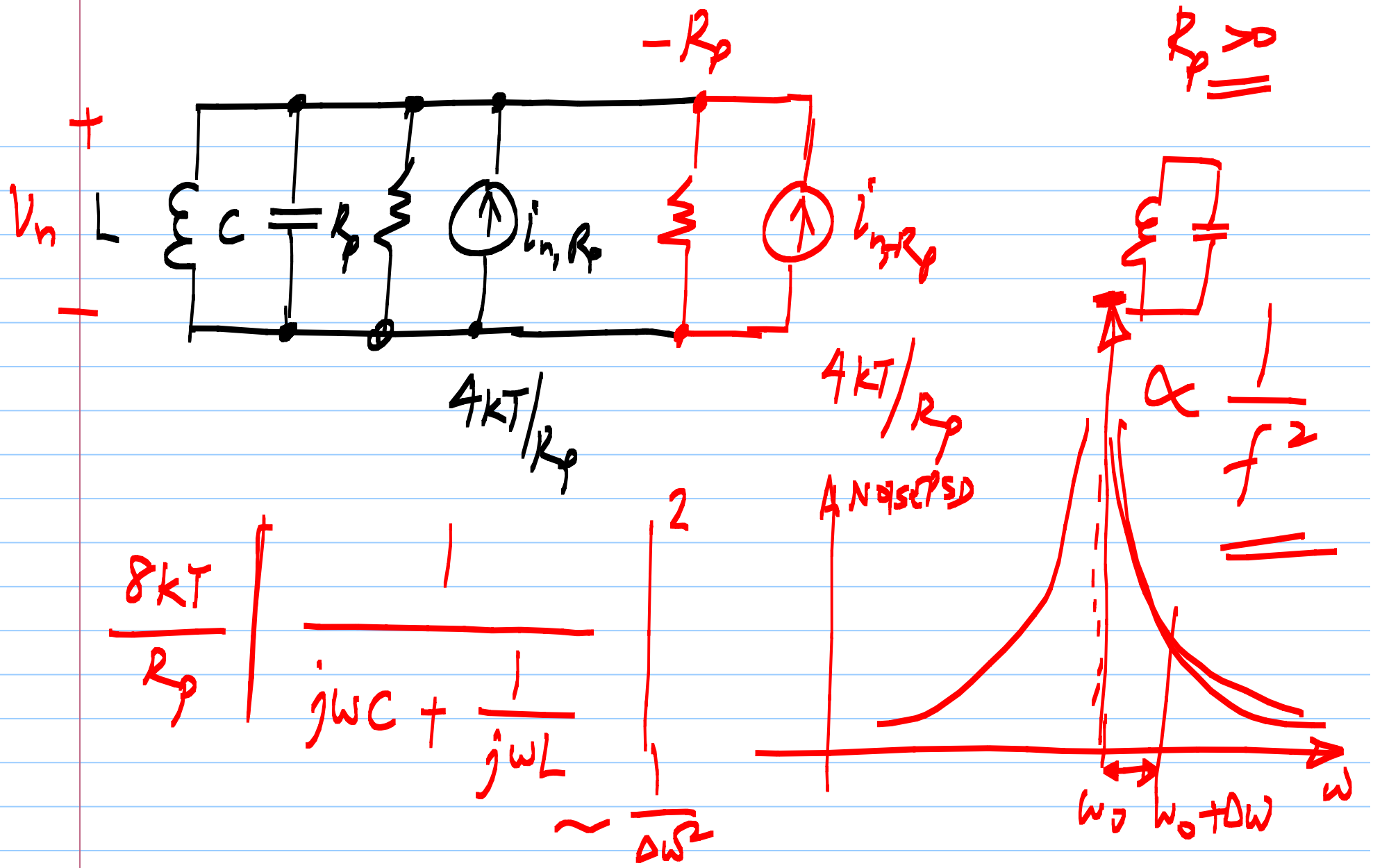
$$G_m > \frac{1}{R_p}$$






$V_p \cdot \cos(\omega_0 t)$
+
L
C
$R_p \leftarrow Z_i$
−
+
i_{am}
i_{am}
$+I_o$
$-I_o$
V_{am}
$|Z_i|$
R_p
3dB
$BW = \frac{\omega_0}{Q}$
ω
$\omega_0 = 1/\sqrt{LC}$
$3\omega_0$
$5\omega_0$
$j\omega C = \frac{1}{j\omega L}$


V_{tank}
$2\pi/\omega_0$
V_p
$\frac{4}{\pi} I_0 R_p$
t
$-V_p$
I_{sw}
$4/\pi\, I_0$
$+I_0$
t
$-I_0$


$-R_p$
$R_p \gg$
+
V_n
L
C
R_p
i_{n,R_p}
i_{n,R_p}
$4kT/R_p$
$4kT/R_p$
ANOISE PSD
$\propto \frac{1}{f^2}$
$\frac{8kT}{R_p} \left| \frac{1}{jwC + \frac{1}{jwL}} \right|^2 \sim \frac{1}{\Delta w^2}$
w_0
$w_0 + \Delta w$
w