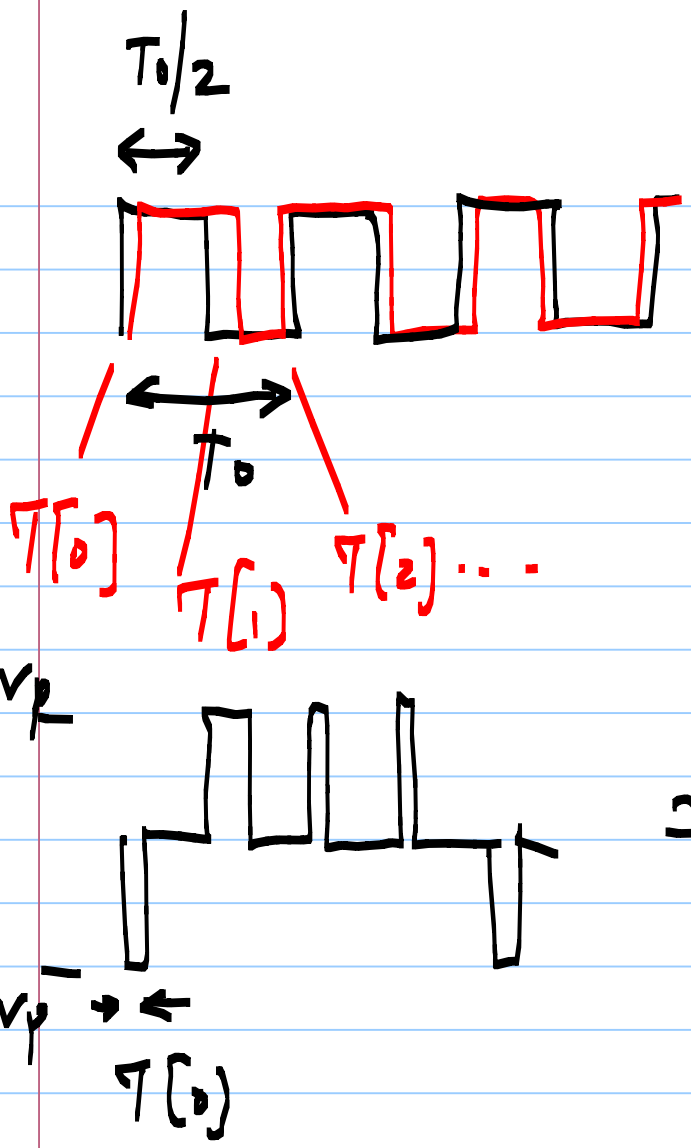
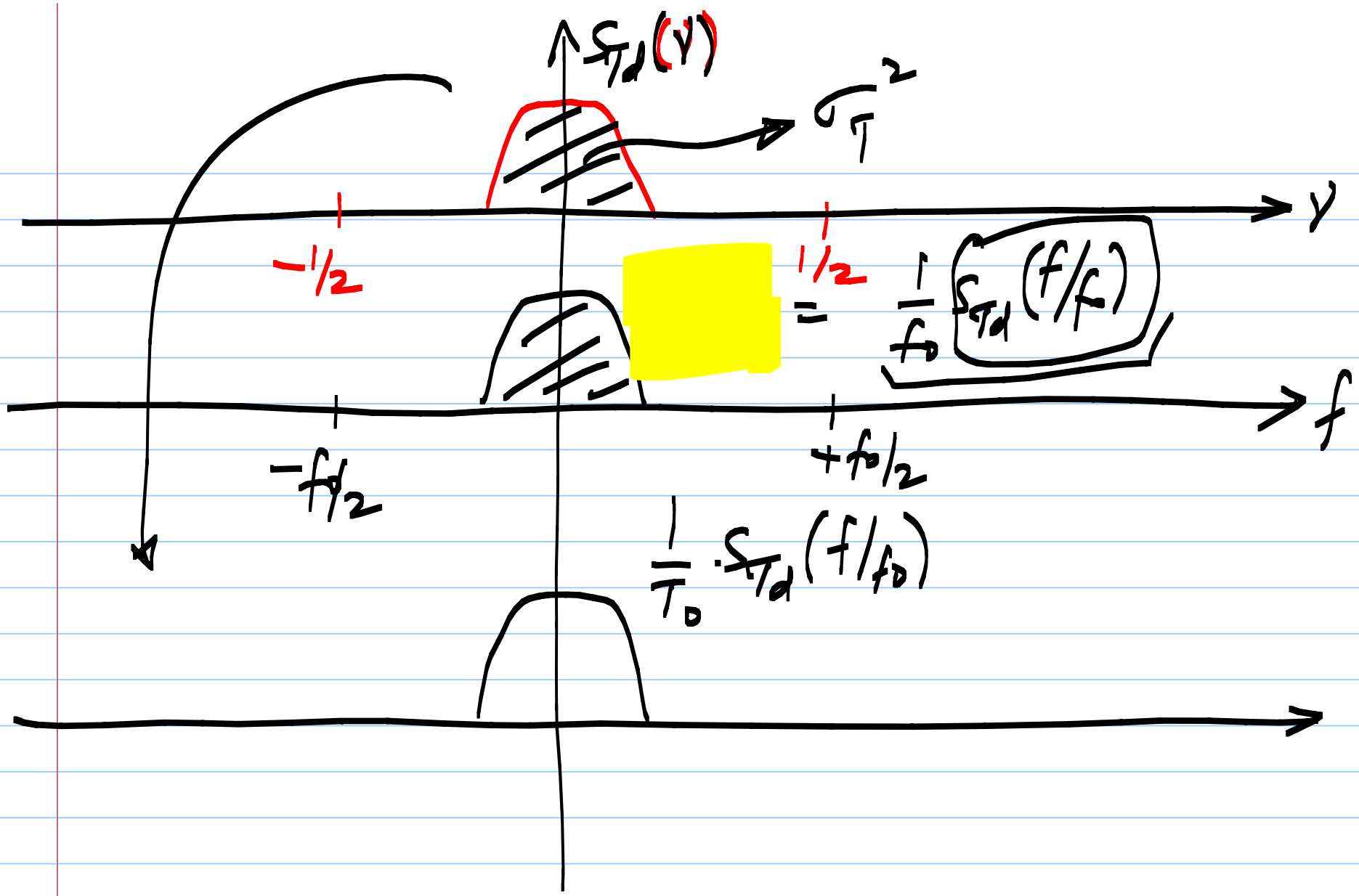


$$\simeq \underbrace{2V_p \sum_{k=-\infty}^{\infty} \tau[k](-1)^k \delta\left(t - k\,T_0/2\right)}$$

2x amplitude @ odd harmonics

0 @ even harmonics

$$\sum (-1)^k \delta\left(t - k\,T_0/2\right) \quad \frac{1}{T_0}$$


$S_{Td}(\nu)$
σ_T^2
ν
$-1/2$
$1/2$
$=$
$\frac{1}{f_0} S_{Td}(f/f_c)$
f
$-f_0/2$
$+f_0/2$
$\frac{1}{T_0} \cdot S_{Td}(f/f_0)$

$$\sum_{n=-\infty}^{\infty} T[k]\ \delta(t - nT_0)$$

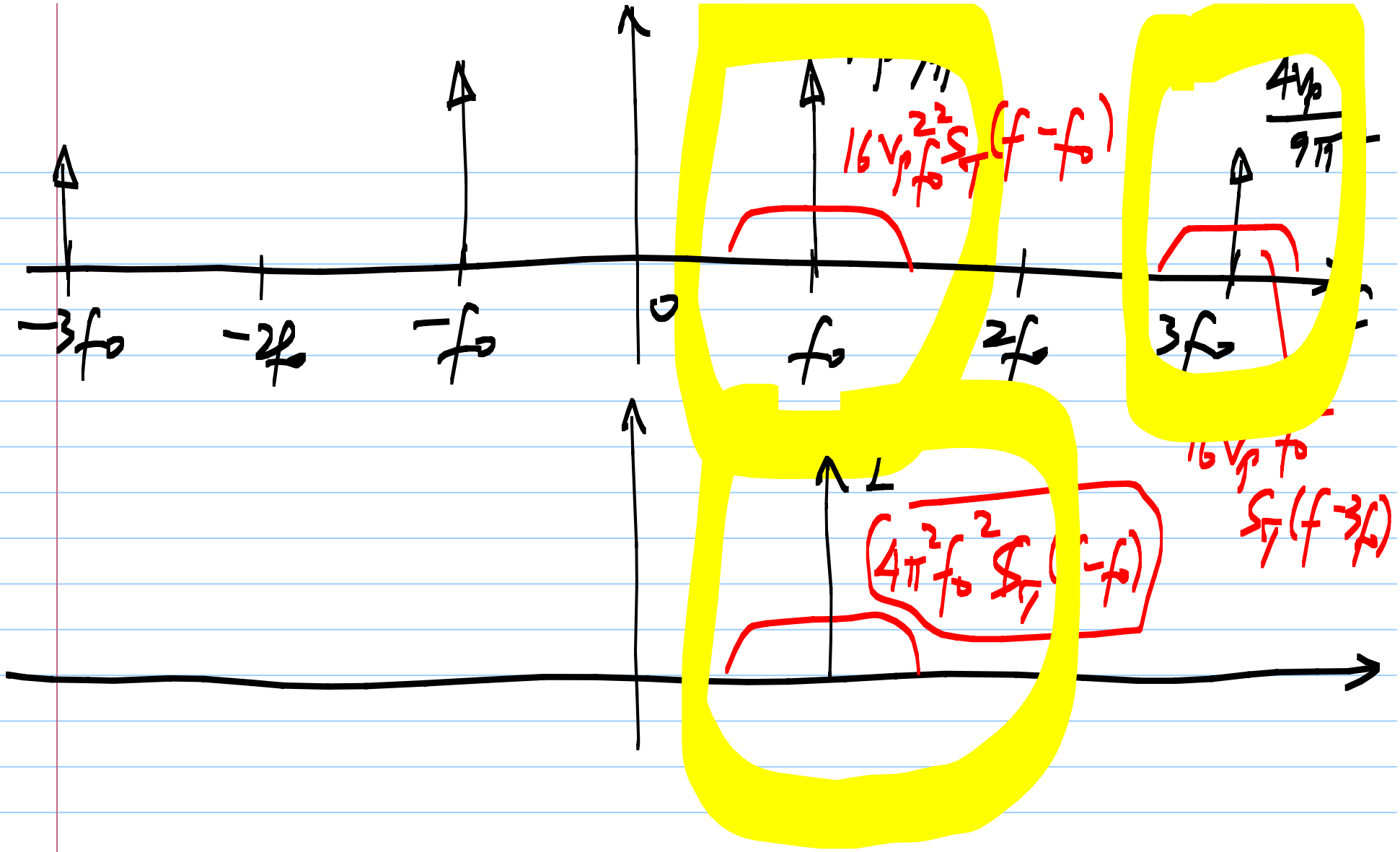
$$\frac{1}{T_0} S_{Td}(f/f_0) = \frac{f_0^2 S_T(f)}{\sum_n f_0^2 S_T(f - nf_0)}$$

$$2V_p \sum_{n=-\infty}^{\infty} T[k](-1)^k \delta\left(t - k\frac{T_0}{2}\right)$$

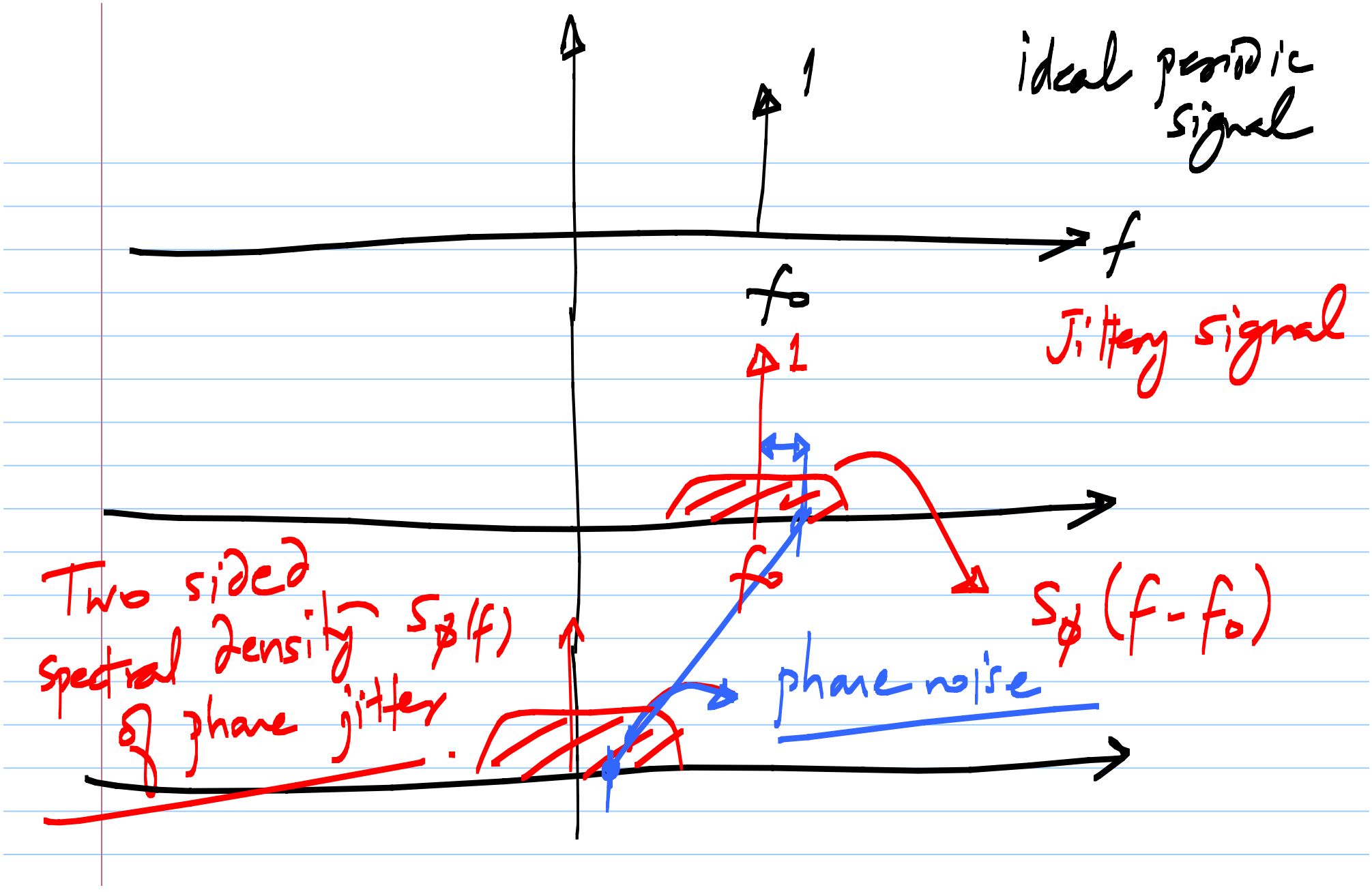
$4\times$

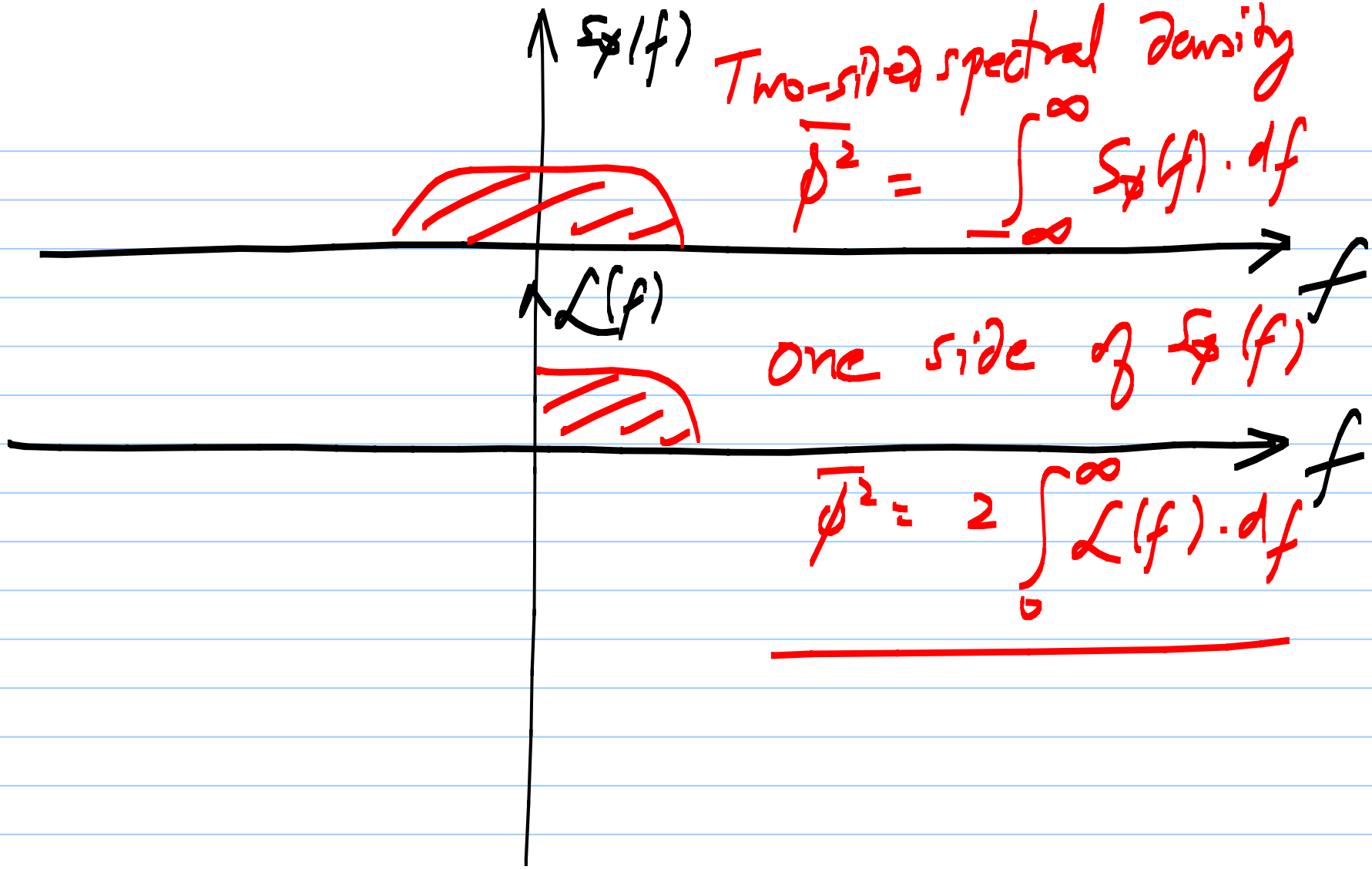
$4V_p^2$

$$16 V_p^2 f_0^2 \sum_{n:\,odd} S_T(f - nf_0)$$


$-3f_0$
$-2f_0$
$-f_0$
0
f_0
$2f_0$
$3f_0$
$16V_p^2 f_0^2 S_T(f-f_0)$
$\frac{4V_p}{9\pi}$
$16V_p f_0$
$S_T(f-3f_0)$
$4\pi^2 f_0^2 S_T(f-f_0)$

$T[n]$: Time jitter (seconds)	$S_T(f)$
$f_0 T[n]$: Unit interval jitter (UI)	$f_0^2 S_T(f)$
$2\pi f_0 T[n]$: Phase jitter (radians)	$4\pi^2 f^2 S_T(f)$
	$= S_\phi(f)$


1
ideal periodic signal
f
f_0
Jittery signal
1
Two sided spectral density $S_\phi(f)$ of phase jitter.
f_0
$S_\phi(f-f_0)$
phase noise

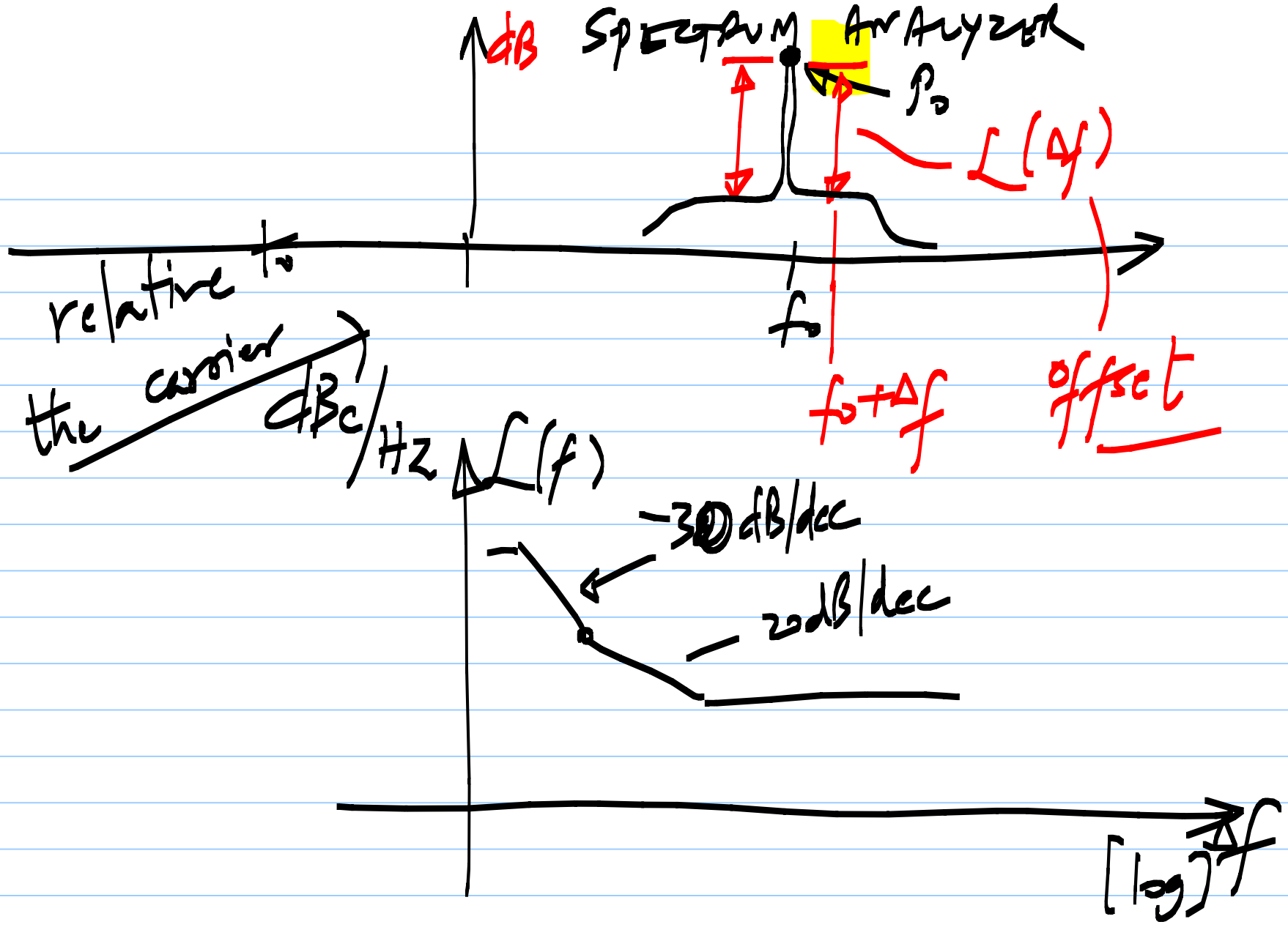


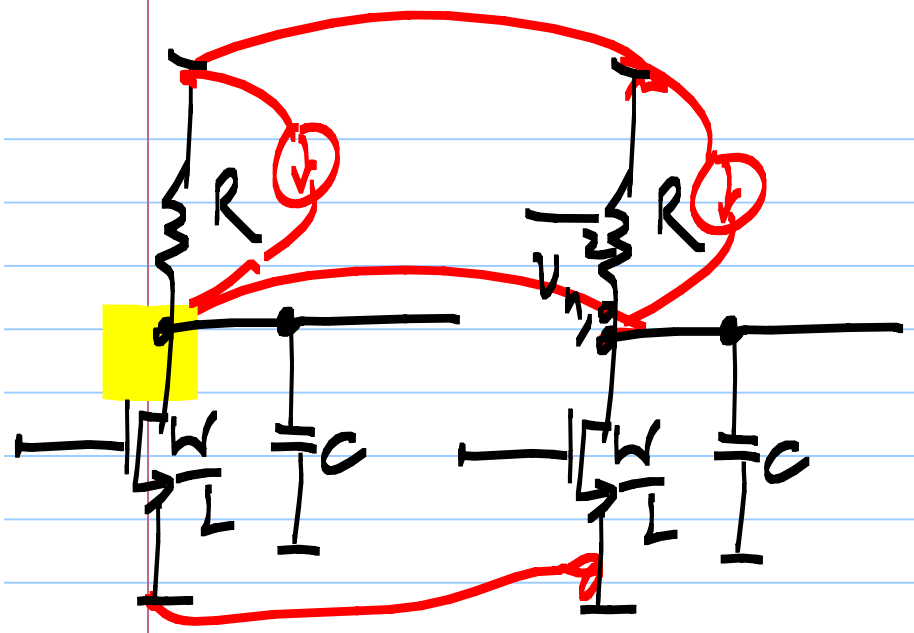
Two-sided spectral density

$$\overline{\phi^2} = \int_{-\infty}^{\infty} S_\phi(f) \cdot df$$

one side of $S_\phi(f)$

$$\overline{\phi^2} = 2 \int_{0}^{\infty} \mathcal{L}(f) \cdot df$$

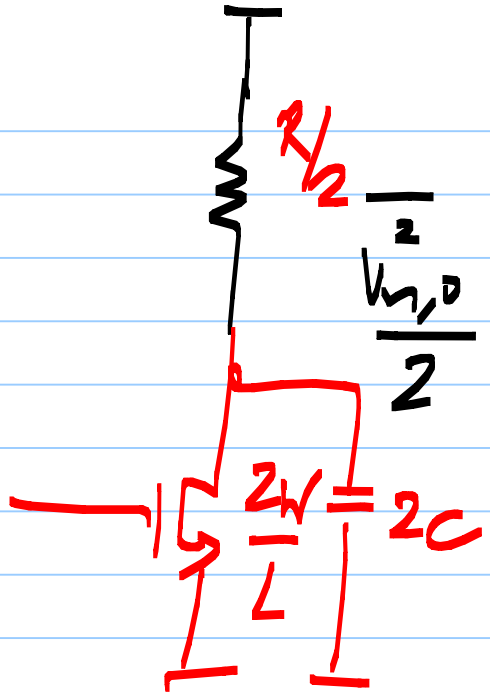

dB
SPECTRUM ANALYZER
P_0
$\mathcal{L}(\Delta f)$
relative to the carrier
dBc/Hz
f_0
$f_0+\Delta f$
offset
$\mathcal{L}(f)$
-30 dB/dec
-20dB/dec
log
Δf



$4kT/R$

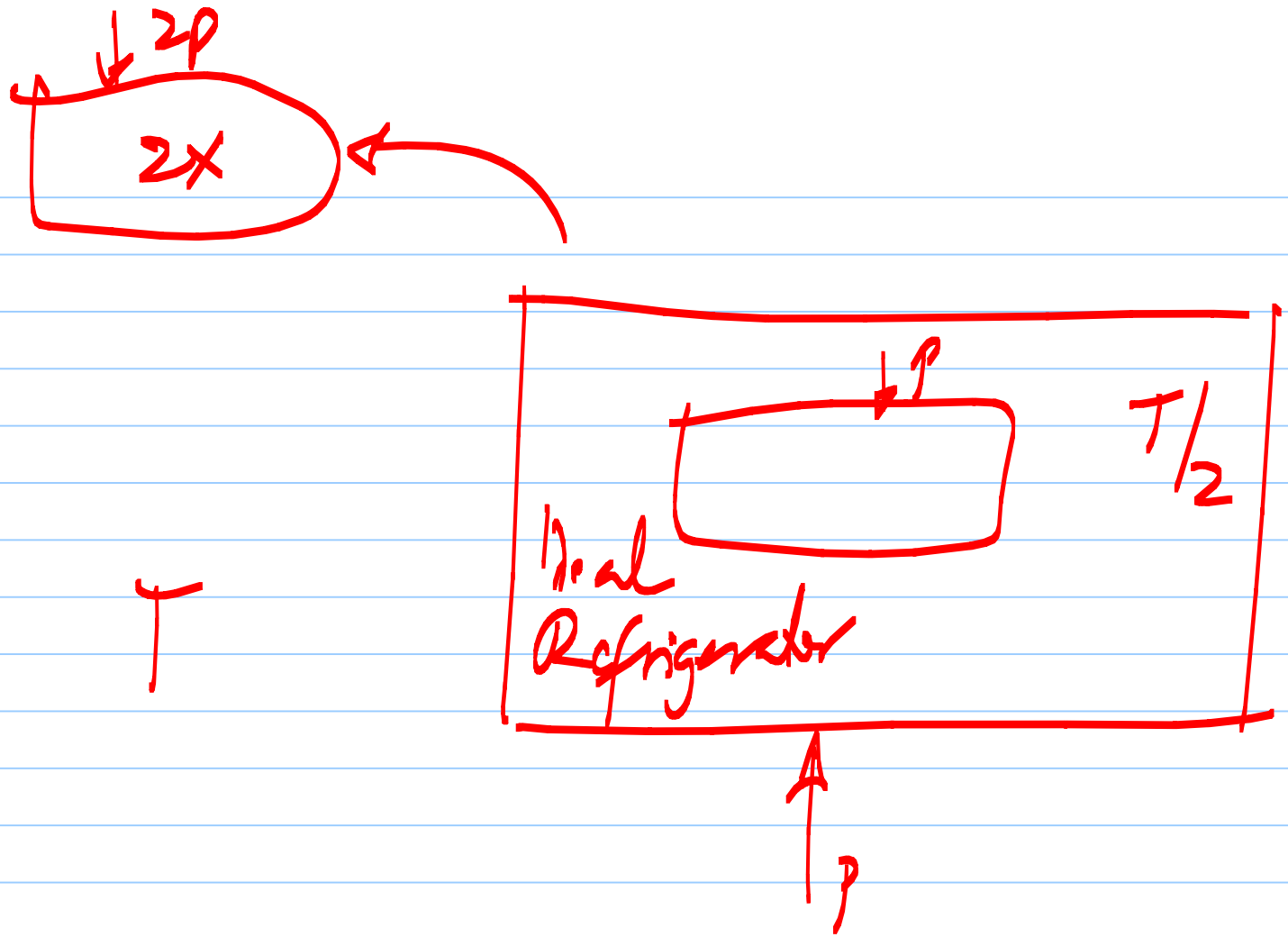
$\overline{v_{n,o}^2}$

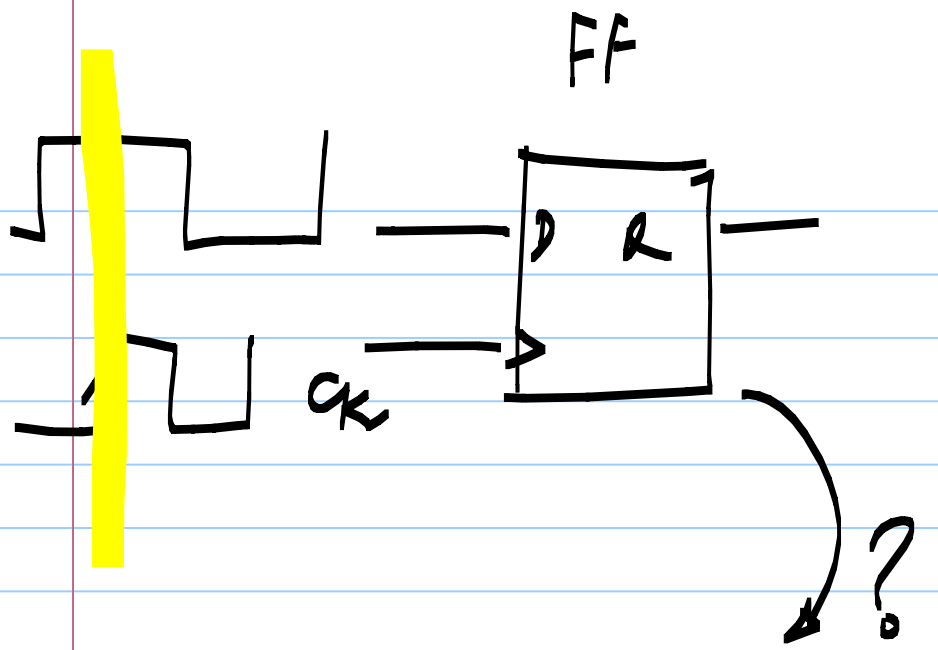
$\frac{8}{3}kTg_m$

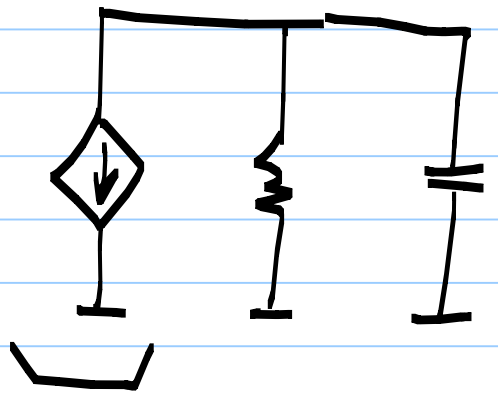


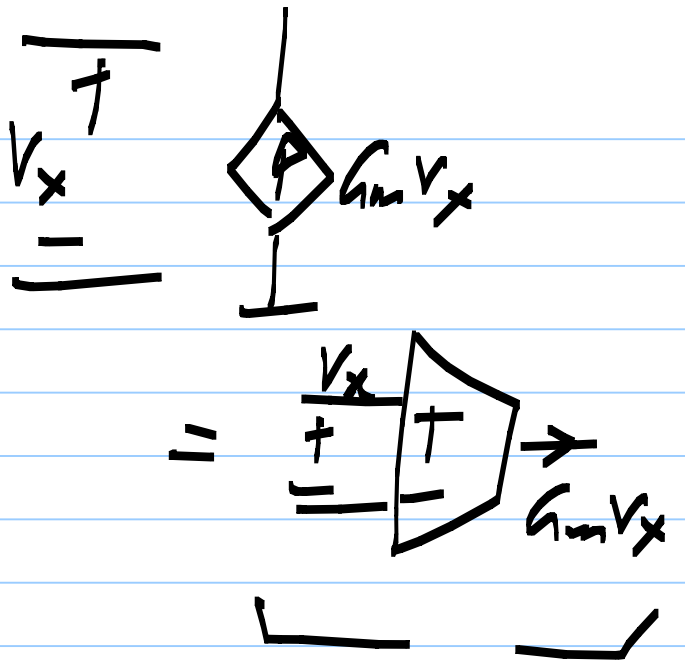
1/2 the noise (PSD)

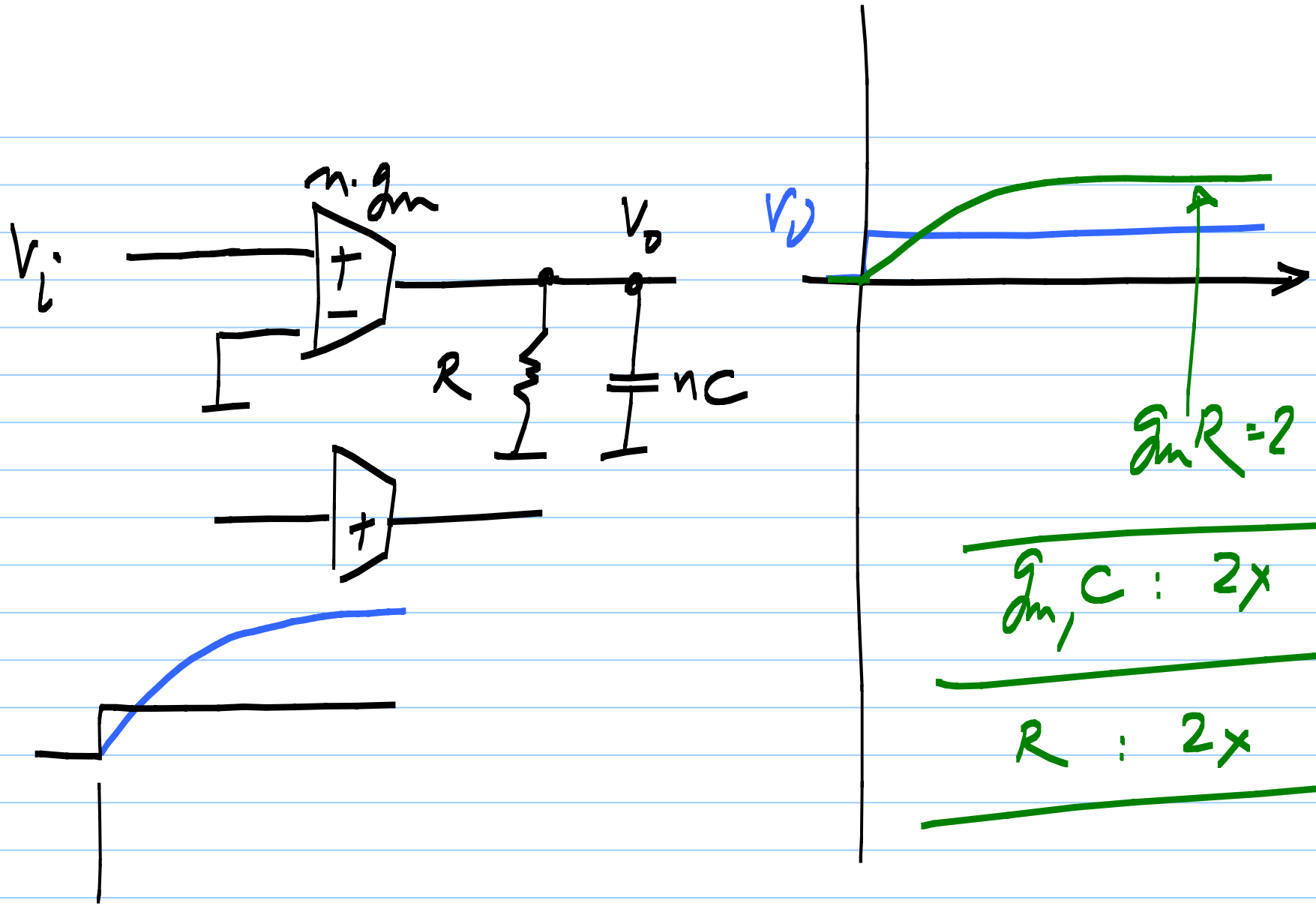
2x the power


2p
2x
p
T/2
Ideal
Refrigerator
T
p


FF
D
Q
CK
?




+
V_x
−
$G_m V_x$
V_x
+
−
=
+
−
$G_m V_x$


$n \cdot g_m$
V_i
V_o
R
nC
V_o
$g_m R = 2$
$g_m, C : 2x$
$R : 2x$