ECE 614 Advanced Analog IC Design

BOISE STATE UNIVERSITY

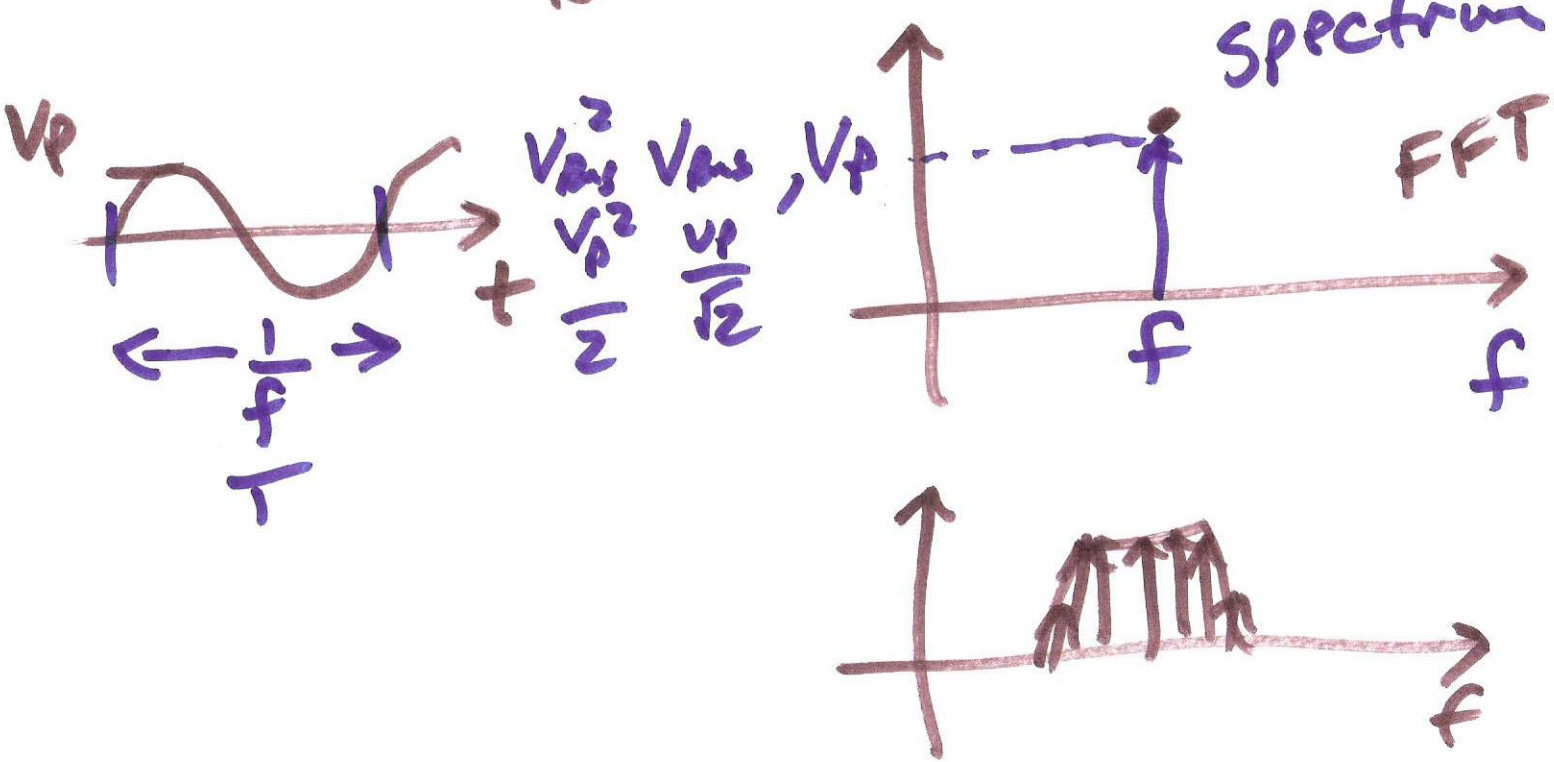
Sept. 15, 2011

Lecture 8

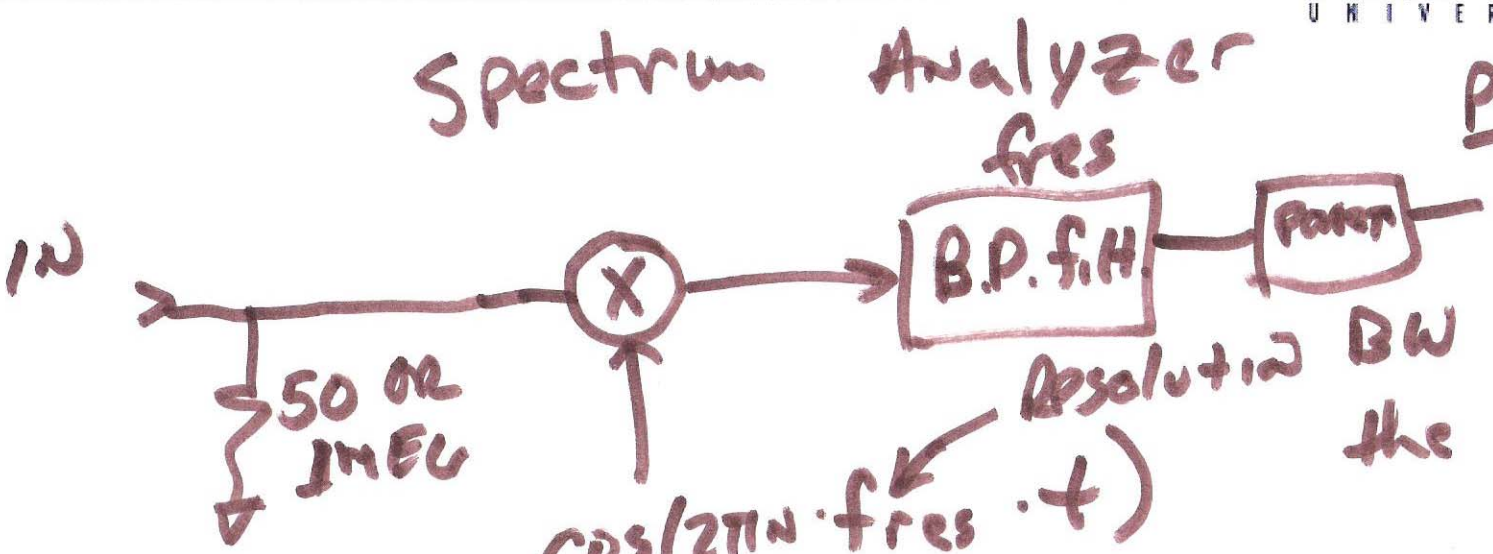
Power Spectral Density

NON-Random signals

Deterministic signals



1)



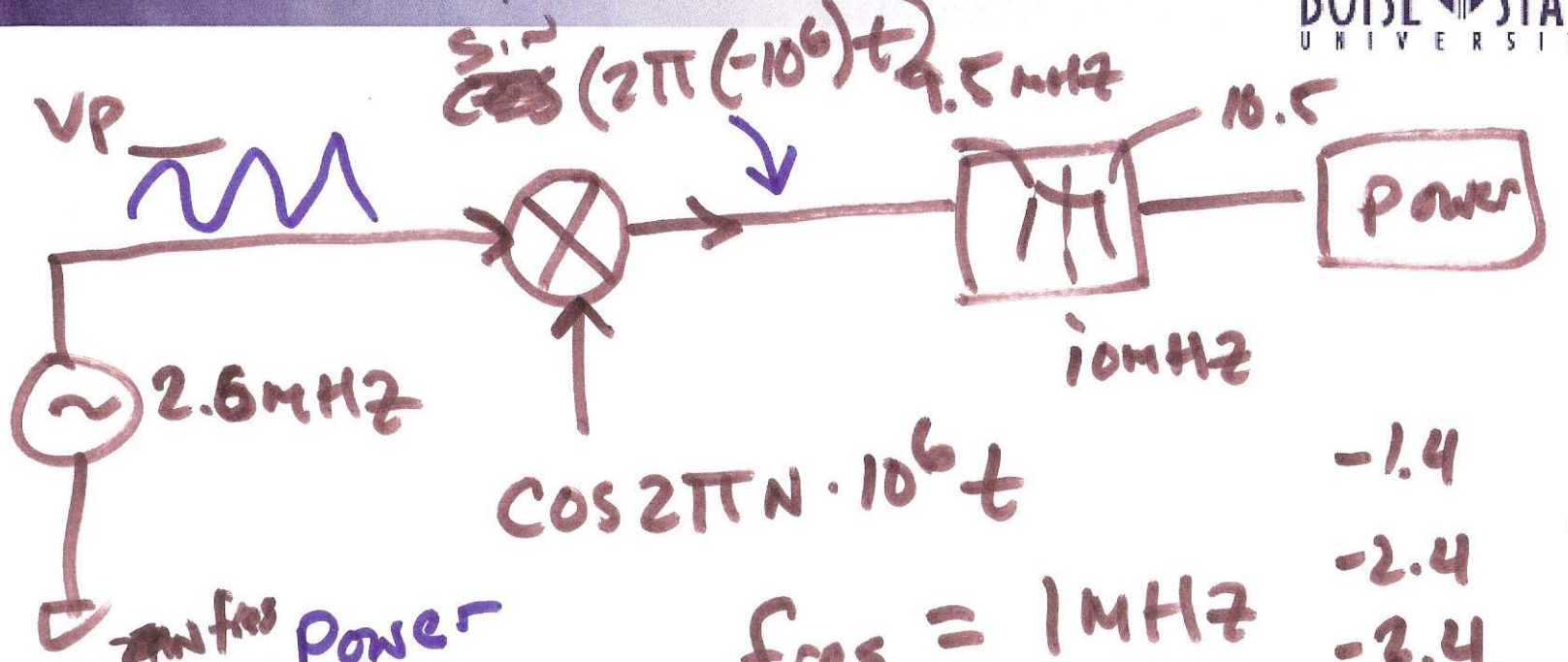
$\frac{W}{Hz}$, $\frac{V^2}{Hz}$, $\frac{A^2}{Hz}$

$\frac{V}{\sqrt{Hz}}$ $\frac{A}{\sqrt{Hz}}$

$$\cos A \cdot \sin B = \frac{1}{2}\left(\sin(B-A) + \sin(A+B)\right)$$

2)

Deterministic signal



$\cos 2\pi N \cdot 10^6 t$

$f_{res} = 1MHz$

$N \to 0, 15$

	transfer	power
N=0	0	0
N=1	1MHz	0
N=2	2MHz	0
N=3	3MHz	0
N=4	4MHz	0
N=5	5MHz	0
N=6	6MHz	0
N=7	7MHz	1/2

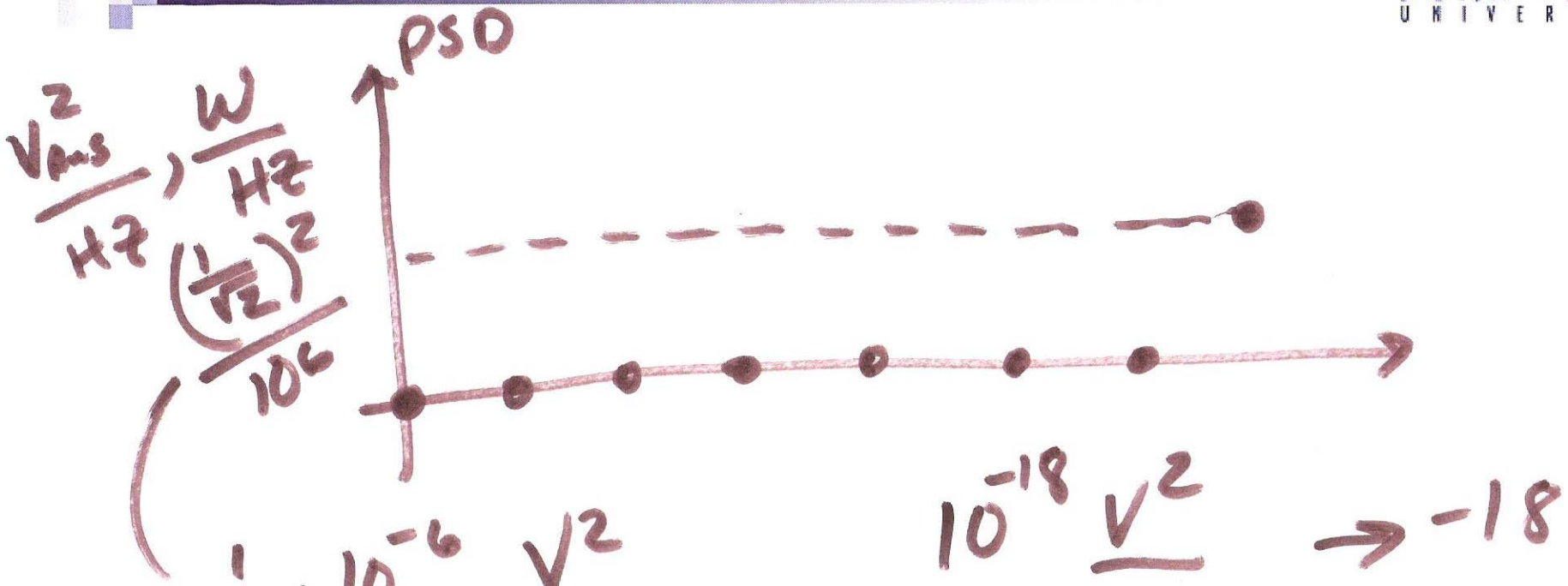
	-1.4	6.6
	-2.4	7.6
	-3.4	8.6
	-4.4	9.6

$\cos A \cdot \sin B \underset{N=3}{=} -10.4$ 1/2

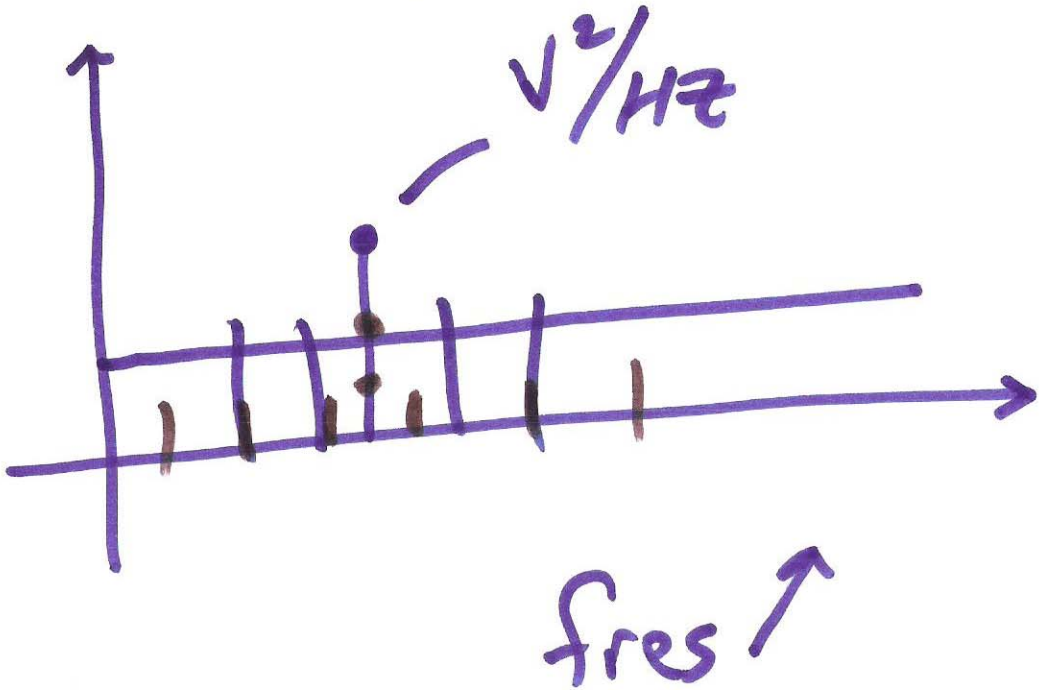
$\frac{1}{2}(\sin(B-A) + \sin(A+B))$

N=1	1.6	3.6
N=2	.6	4.6
	-0.4	5.6

3)


PSD
$\frac{V_{rms}^2}{Hz}, \frac{W}{Hz}$
$\frac{\left(\frac{1}{Hz}\right)^2}{10^6}$
$\frac{1}{2} \cdot 10^{-6} \frac{V^2}{Hz}$
$10^{-18} \frac{V^2}{Hz} \rightarrow -18$
$\frac{1}{2} \frac{mV^2}{Hz}$
$10^{-9} \frac{V}{\sqrt{Hz}}$

4)



5)

circuit testing

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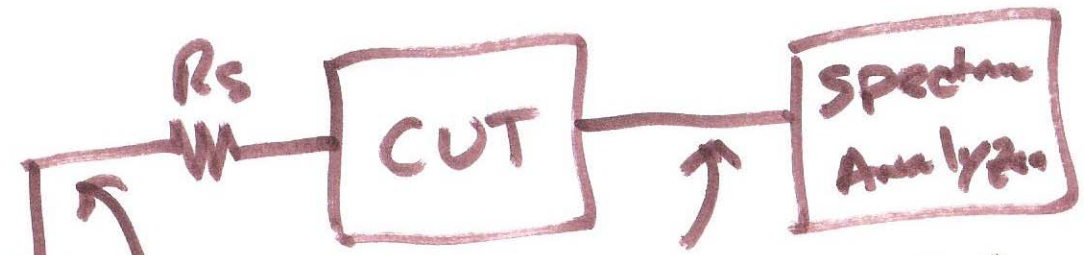
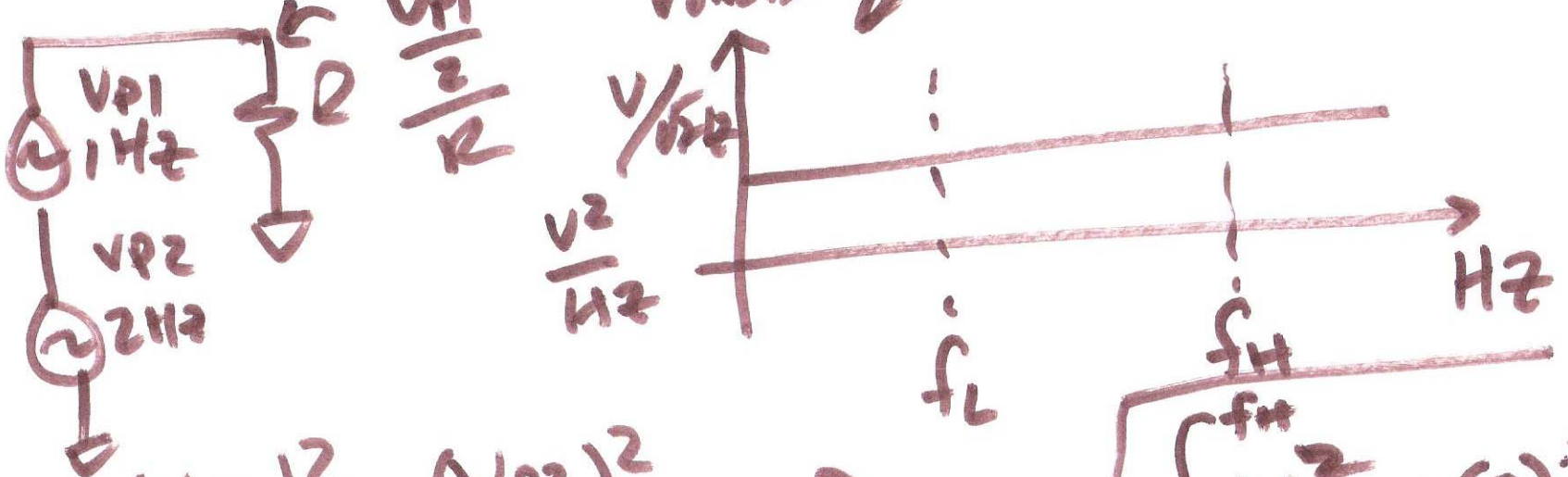


No source

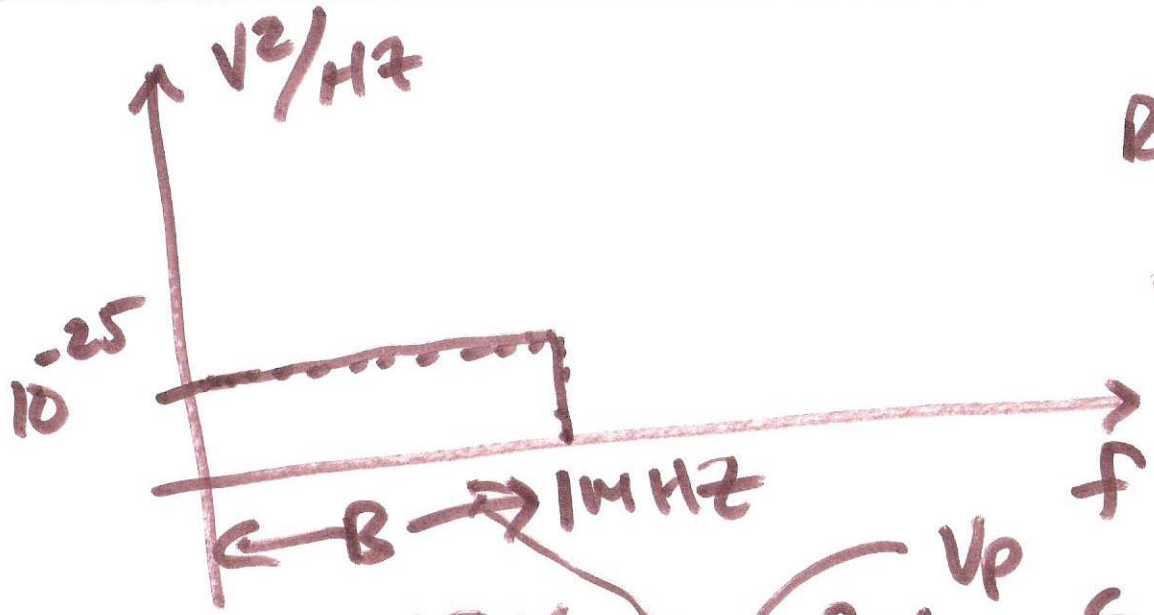
$V_{ONOISE}(f)$, $\frac{V}{\sqrt{Hz}}$



$$\frac{\left(\frac{V_{P1}}{\sqrt{2}}\right)^2 + \left(\frac{V_{P2}}{\sqrt{2}}\right)^2}{R} = P_{total}$$

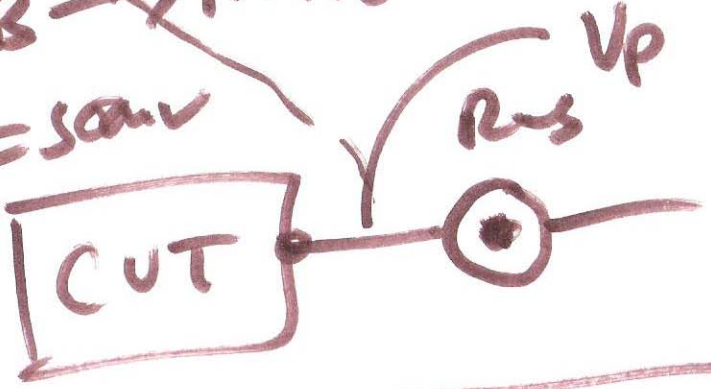
$$\sqrt{\int_{f_L}^{f_H} V_{ONOISE}^2(f) \cdot df} = V_{RMS}$$

b)

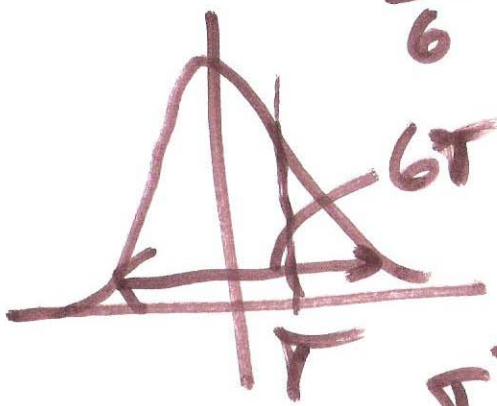


Resolution ~ 2mV

PDF $\frac{3V}{6} = T = 500mV$



$SNR = \frac{V_p/\sqrt{2}}{10^{-9.5}}$



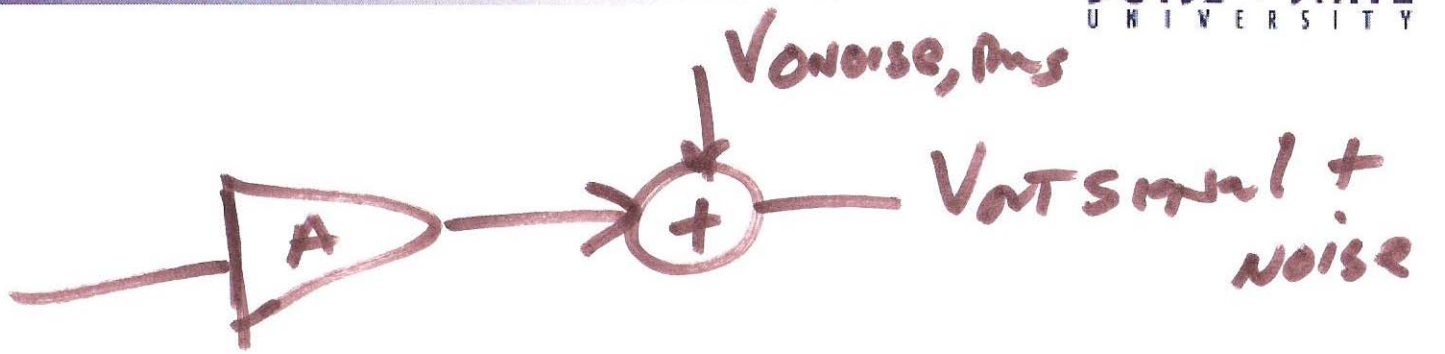
$V_{Rms} = \sqrt{\int_0^{10^6} 10^{-25} \frac{V^2}{Hz} \cdot df} = \sqrt{B \cdot 10^{-25}}$

$= 10^3 \cdot 10^{-12.5}$

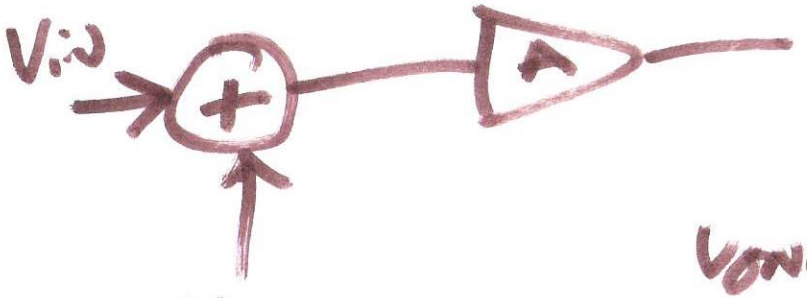
$= 10^{-9.5}$ V

Rms T^2 mean-square V_{Rms}^2

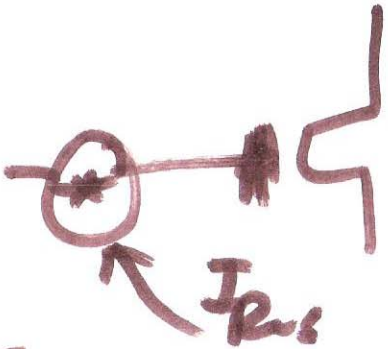
7)



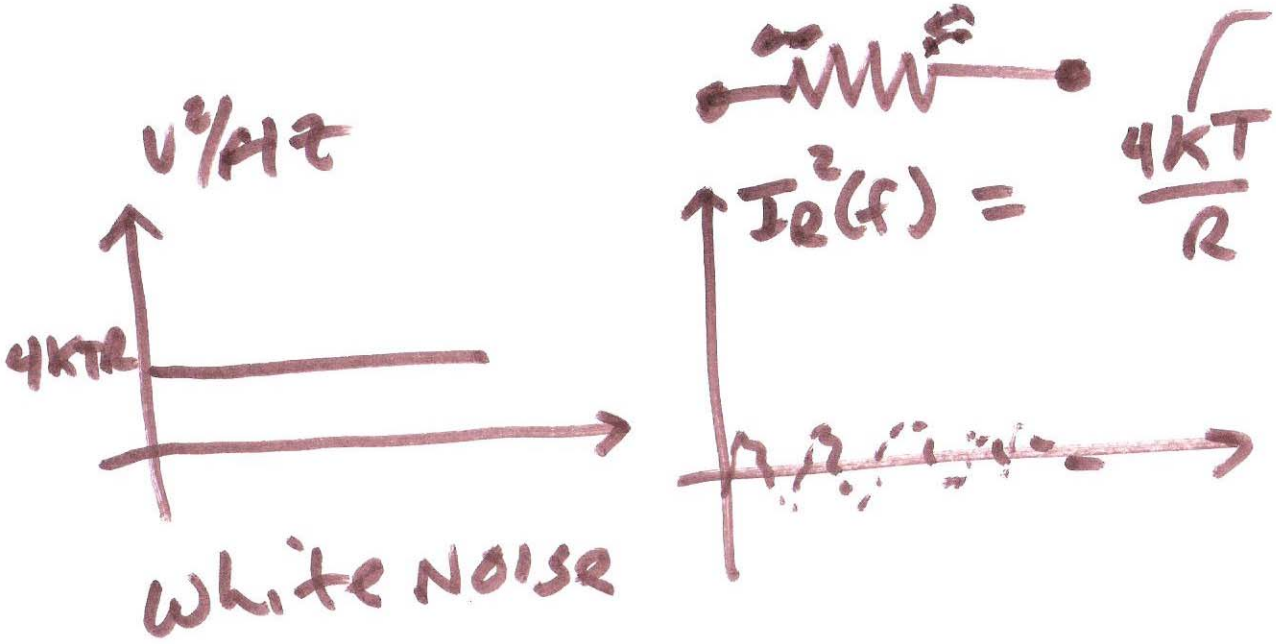
SNR:

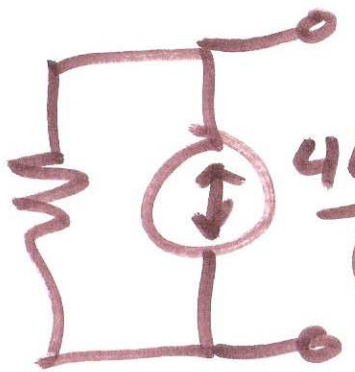


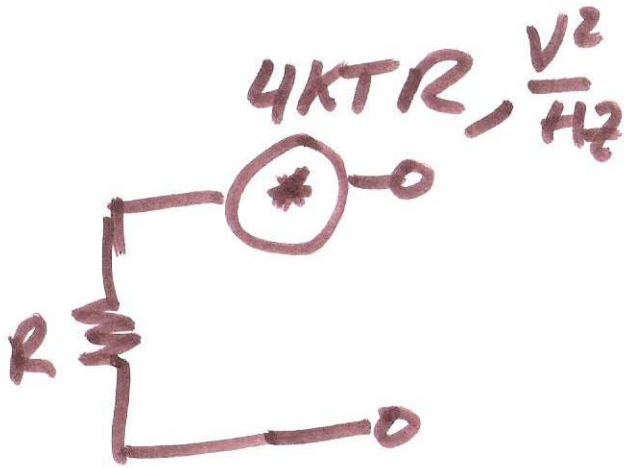
$V_{INOISE,RMS} = \frac{V_{ONOISE,RMS}}{A}$



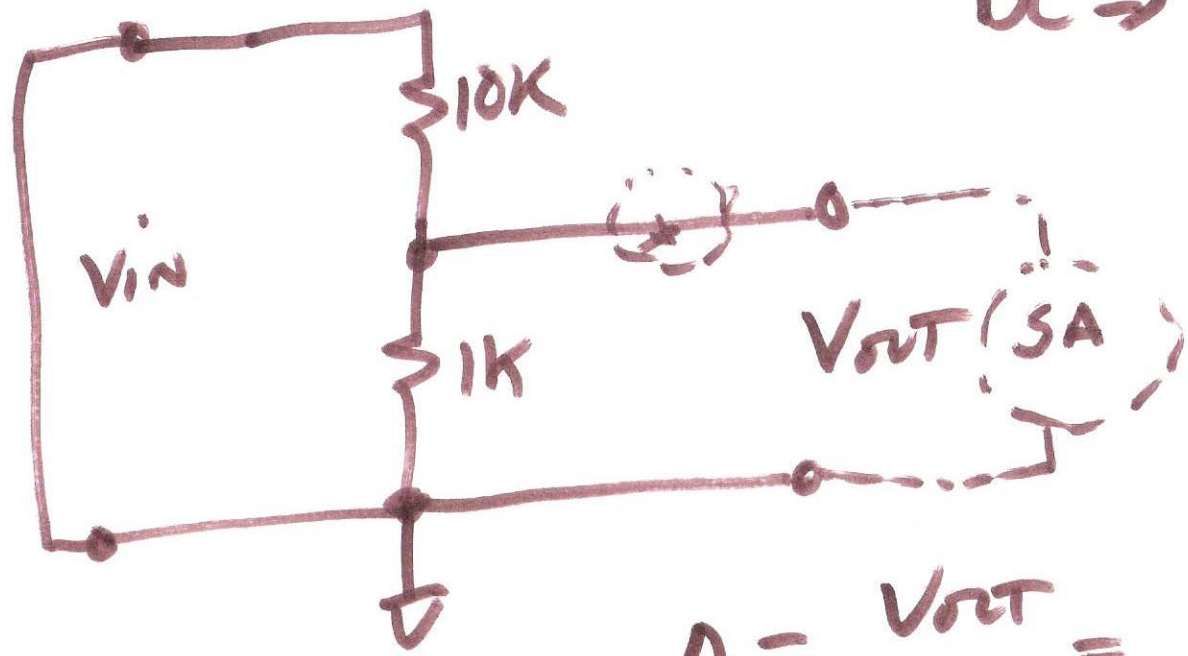
Thermal Noise





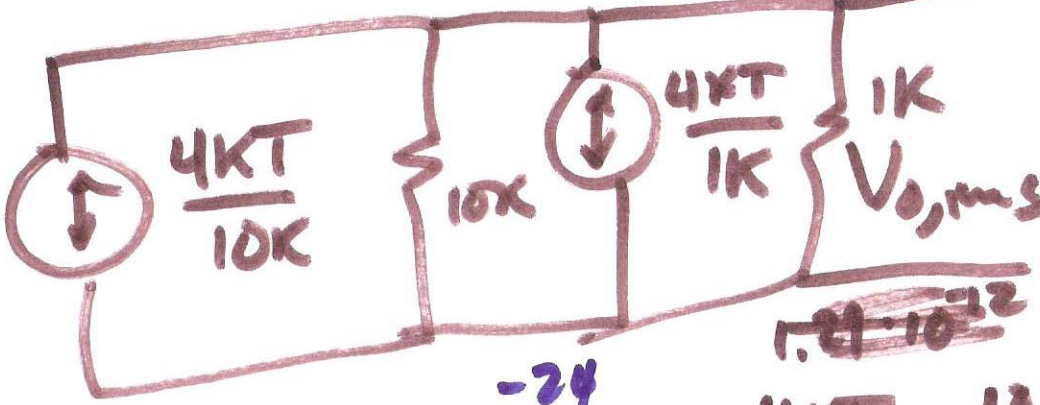


DC ⇒ 1KHz



$4 \cdot 10^{-10.5}$ V

$$A = \frac{V_{OUT}}{V_{IN}} = \frac{1K}{10K+1K} = \frac{1}{11}$$



$900 \cdot 18 \cdot 10^{-24}$

$16.2K \cdot 10^{-24}$

$\frac{4KT}{10K} \cdot \frac{10K \cdot 1K}{1K+10K}$ + $\frac{4KT}{1K}\left(\frac{10K \cdot 1K}{1K+10K}\right)$

1.66×10^{-24} $16.66 \cdot 10^{-24}$

10)