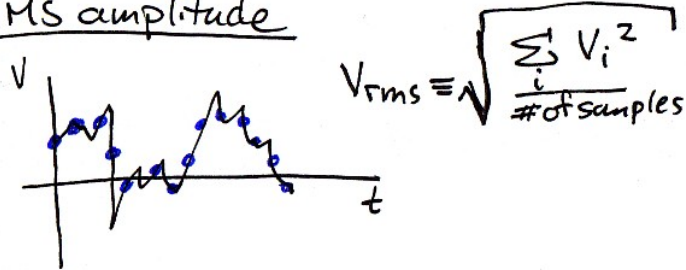


Physics 326a-2011 Class 3 Thursday/Friday 9/8-9/11 Summary

Noise vs. Interference

Noise: random, intrinsic to sample/apparatus  
 Interference: external, usually periodic, always undesired

RMS amplitude



Addition of uncorrelated noise sources

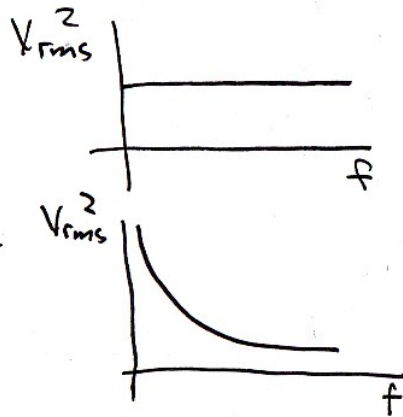
$$V_{TOT\ rms} = \sqrt{V_{1\ rms}^2 + V_{2\ rms}^2 + \dots}$$

Addition in quadrature

Types of noise

White noise:

on average, same amplitude at all frequencies



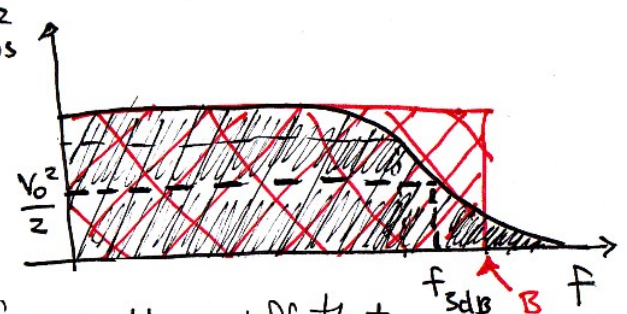
1/f noise:  $V_{rms}^2 \propto \frac{1}{f}$   
 (occurs in virtually all systems)

Equivalent Noise Bandwidth (ENBW)

Noise at different frequencies is incoherent

$\Rightarrow$  Total noise  $\propto \sqrt{\text{Bandwidth}}$

e.g. white noise signal passed through lo-pass:

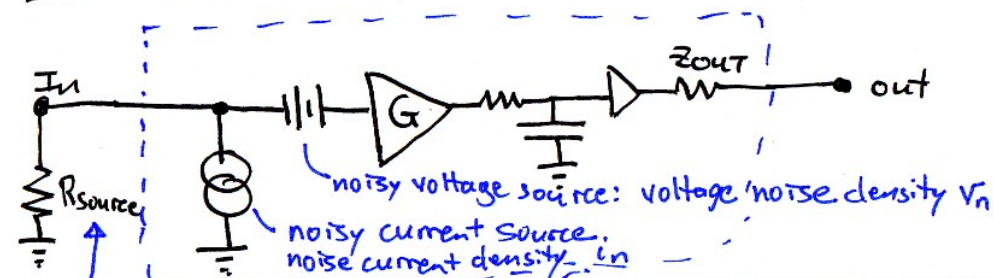


ENBW = B = bandwidth of a sudden cutoff that gives same area under the  $V_{rms}^2$  vs.  $f$  curve

For a single lo-pass,  $B = \frac{\pi}{2} f_{3dB}$

Johnson noise  $V_{rms} = \sqrt{4k_B T R B}$

Model for amplifier noise



output impedance of previous stage

$$V_{rms\ at\ out} = G \sqrt{B} \sqrt{v_n^2 + (i_n R)^2 + 4k_B T R_{source}}$$