

PHYS 3360 / AEP 3630

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Lecture 39

Electrical Noise

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Signal to noise ratio

$$SNR_{dB} =$$

Noise figure

$$NF_{dB} =$$

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E.g. 1dB noise figure :

## Sources of Noise

I. Intrinsic

II. Interference

### Intrinsic sources of noise

1) Johnson (thermal) noise



$$(\sigma_n)_{\text{rms}} =$$

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- "white noise"

- "gaussian noise"

Ex:  $R=20k\Omega$  @  $T=300K$ ,  $B=20kHz$

2) Shot noise

Ex:  $i_s = 1A$ ,  $B = 20kHz$

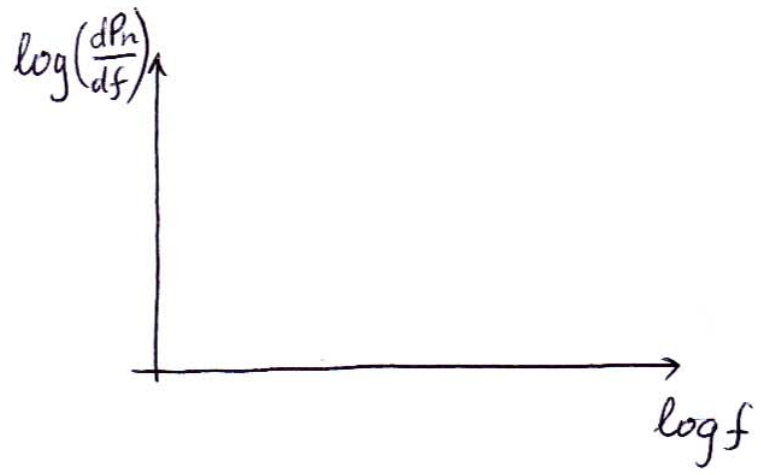
$i_s = 10pA$ , — " —

- also

3)  $1/f$  (flicker) noise

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- a.k.a.
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To minimize intrinsic noise

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- limit
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