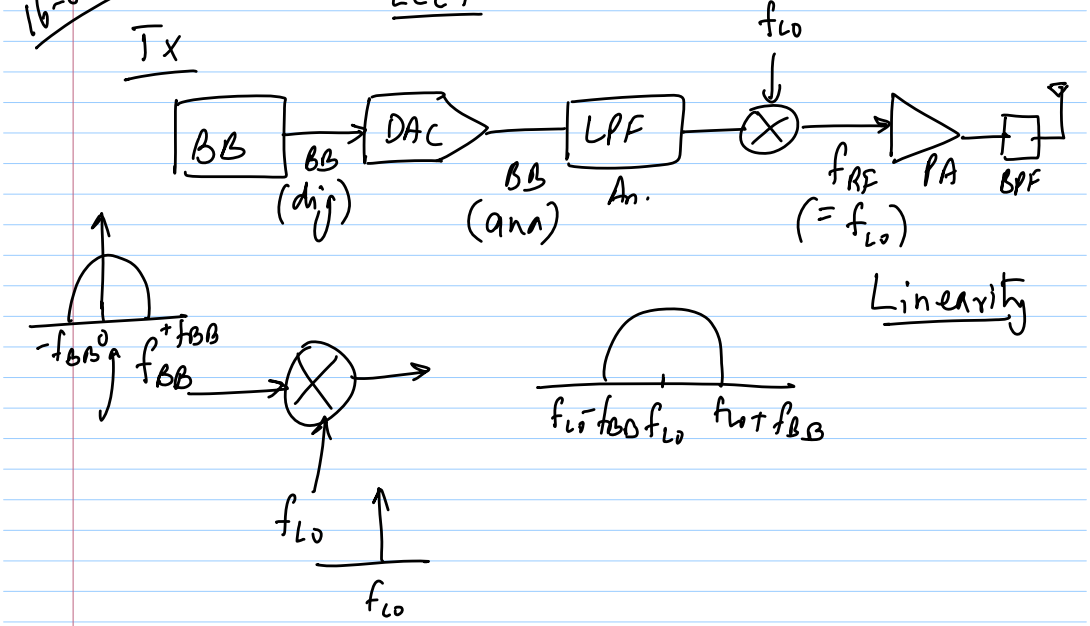
16-8-13

Lec 7

Tx

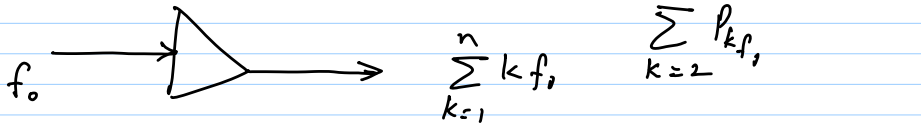


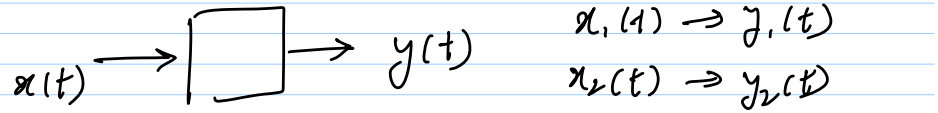
Linearity

Basic RF concepts

1) Linearity

* HD in amplifier





$a x_1(t) + b x_2(t) \rightarrow a y_1(t) + b y_2(t)$

* No offsets
* Non-zero initial conditions

2) Time invariance

$x(t) \rightarrow y(t)$

$x(t-\tau) \rightarrow y(t-\tau) \quad \forall \tau$

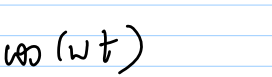
time variant system:

Mixer

NL & TV

Effects of Nonlinearity

$x(t) = A \cos(\omega t)$



$y(t) \approx \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t)$

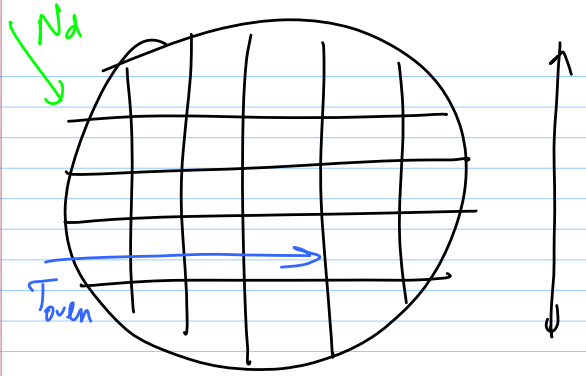
$= \alpha_1 A \cos(\omega t) + \alpha_2 A^2 \cos^2(\omega t) + \alpha_3 A^3 \cos^3(\omega t)$

$= \alpha_1 A \cos(\omega t) + \frac{\alpha_2 A^2}{2}\left[1 + \cos(2\omega t)\right] + \alpha_3 \frac{A^3}{4}\left[3\cos(\omega t) + \cos(3\omega t)\right]$

$$= \underbrace{\frac{\alpha_2 A^2}{2}}_{\text{DC offset}} + \underbrace{\left(\alpha_1 A + \frac{3\alpha_3 A^3}{4}\right)}_{\text{gain}} \cos(\omega t)$$

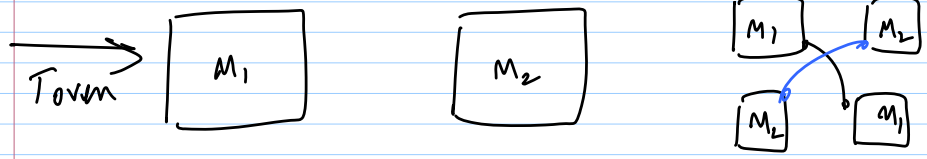
$$+ \underbrace{\frac{\alpha_2 A^2}{2} \cos(2\omega t)}_{2^{nd}\text{ harmonic}} + \underbrace{\frac{\alpha_3 A^3}{4} \cos(3\omega t)}_{3^{rd}\text{ harmonic}}$$

* even harmonics result from even order NL
  - differential symmetry will knock these out
  - mismatches lead to residual even harmonic

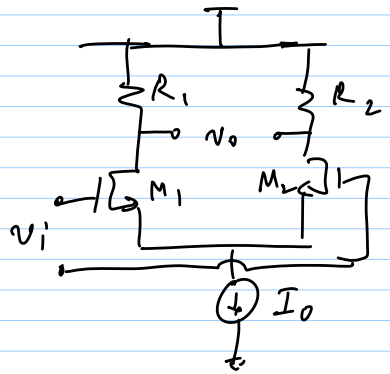


dia = 12 inches

1000's of chips



Diff. symmetry



$M_1 \equiv M_2$

$R_1 \equiv R_2$

* Corner – across dies

$\mu = f(\text{doping}, T, V)$

* Amplitude of n^{th} harmonic

$\propto (A^n + \text{higher powers of } A)$