23-8-13

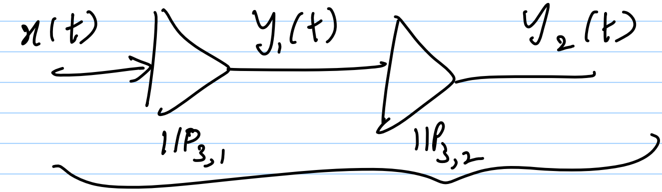
Lec 10

$$A_{1dB} = \sqrt{0.145 \left|\frac{\alpha_1}{\alpha_3}\right|}$$

$$A_{IIP_3} = \sqrt{\frac{4}{3}\left|\frac{\alpha_1}{\alpha_3}\right|}$$

$$\boxed{P_{1dB} \simeq IIP_3 - 9.6\,dB}$$

Cascaded IIP_3



IIP_3 of cascade

$$y_1(t) = \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t)$$

$$y_2(t) = \beta_1 y_1(t) + \beta_2 y_1^2(t) + \beta_3 y_1^3(t)$$

$$= \beta_1(\;) + \beta_2(\;)^2 + \beta_3(\;)^3$$

Separate out 1^{st} & 3^{rd} order terms

$$\Rightarrow A_{IIP_3} = \sqrt{\frac{4}{3}\left|\frac{\alpha_1\beta_1}{\alpha_3\beta_1 + 2\alpha_1\alpha_2\beta_2 + \alpha_1^3\beta_3}\right|}$$

worst-case estimate of Dr.

$$= |\alpha_3\beta_1| + |2\alpha_1\alpha_2\beta_2| + |\alpha_1^3\beta_3|$$

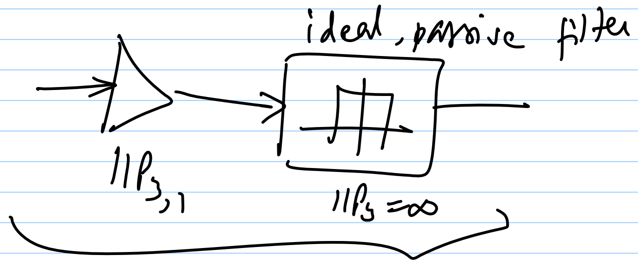
$$\frac{1}{A^2_{IIP_3}} = \frac{3}{4}\,\frac{|\;| + |\;| + |\;|}{|\alpha_1\beta_1|}$$

$$\frac{1}{A^2_{IIP_3}} = \frac{1}{A^2_{IIP_{3,1}}} + \cancelto{0}{\left|\frac{3\alpha_2\beta_2}{2\beta_1}\right|} + \frac{\alpha_1^2}{A^2_{IIP_{3,2}}}$$

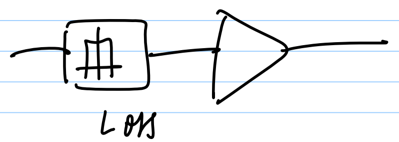
* Diff. system — $\alpha_2 = \beta_2 = 0$
* Even otherwise — in narrow band systems
  - Second harmonic @ output of 1^{st} stage is very small
  - middle term is negligible

$$\boxed{\frac{1}{A^2_{IIP_3}} = \frac{1}{A^2_{IIP_{3,1}}} + \frac{\alpha_1^2}{A^2_{IIP_{3,2}}} + \frac{\alpha_1^2\beta_1^2}{A^2_{IIP_{3,3}}} + \cdots}$$

* IIP_3 of later stages is dominant



$$IIP_3 = IIP_{3,1}$$

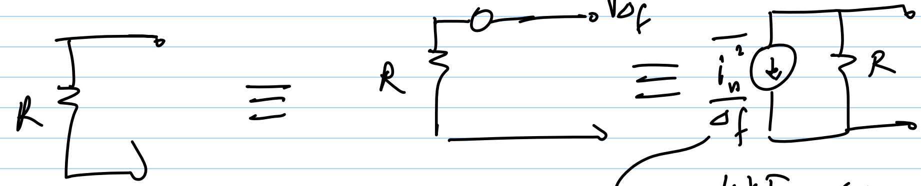


IIP_3 will increase

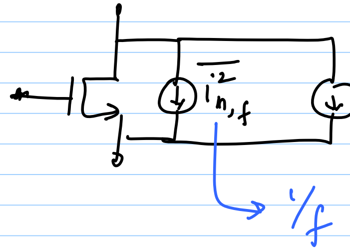
Noise

$$\frac{\overline{e_n^2}}{\Delta f} = 4kTR \quad (V^2/Hz)$$

$$\frac{\overline{e_n}}{\sqrt{\Delta f}} = \sqrt{4kTR}$$



$$= \frac{4kT}{R} \quad (A^2/Hz)$$



$$\overline{i_{n,t}^2} = 4kT\gamma g_{d0} \Delta f$$

white noise

long channel → $g_{d0} = g_m$

$\gamma = 2/3$

short channel

$g_{d0} = g_m/\alpha \; (> g_m)$

$\gamma > 2/3 \quad (2-4)$

$$\frac{g_m}{g_{d0}} = \alpha < 1 \quad \text{(for short channel)}$$

$$\boxed{\frac{\overline{i_{n,t}^2}}{\Delta f} = 4kT\frac{\gamma}{\alpha} g_m}$$