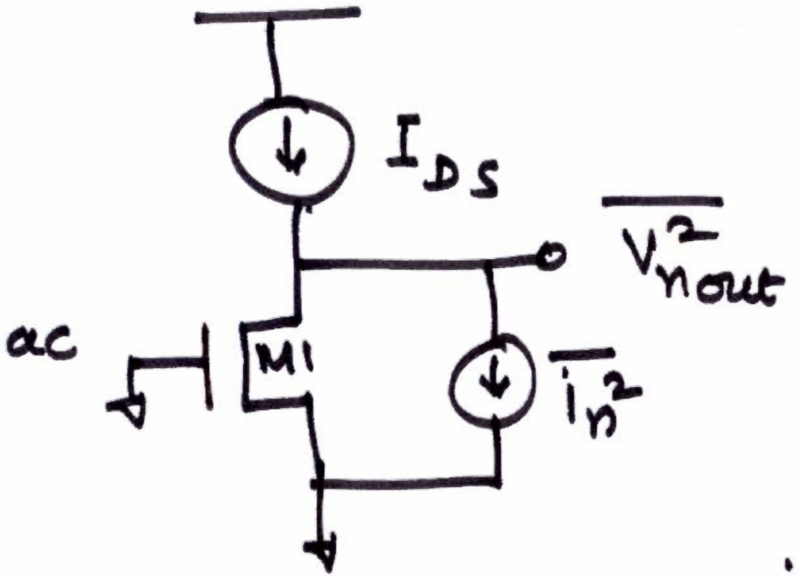
A simple CS Amplifier noise can be now evaluated.



If Rout is output resistance of M1 (r_{o1}) & Current Source has $R_{out} \to \infty$ then Noise current $\sqrt{\overline{i_n^2}}$ flows through r_{o1} output resistance

$$\therefore \overline{V^2_{n\,out}} = \overline{i_n^2} \cdot r_{o1}^2$$

$$= 4kT\left(\tfrac{2}{3} g_m\right) r_{o1}^2$$

$$\text{or } \sqrt{\overline{V^2_{n\,out}}} = \sqrt{\tfrac{8}{3} kT g_m} \cdot r_{o1} \quad V/\sqrt{Hz}$$

$\therefore$ Low Noise $\Rightarrow$ low g_m, (Lower Gains)

1/f Noise

- Famously known as Flicker Noise.
- Most Believe that this Noise is due to random carrier trapping at Interface States (Insulator / Semiconductor Interface) in MOS device.
- It is difficult to accurately predict the Noise Power due to 1/f Noise, as 'Interface' property is strongly dependent on Process Technology.
- This noise power is seen to follow 1/f relation with frequency f.

- In general one models this noise by Noise Voltage source in series to Gate terminal.

- Typically it can be represented as

$$\overline{V^2_{n_{1/f}}} = \frac{K}{C_{ox} W \cdot L} \cdot \frac{1}{f}$$

&

$$\overline{i^2_{n\,1/f}} = \frac{K}{C_{ox} W \cdot L} \cdot g_m^2 \cdot 1/f$$

- The spectral density of Flicker Noise current source is given by

$$\overline{i^2_{n\,1/f}} = \int_{f_1}^{f_2} \frac{K_1}{L^2} \cdot \frac{I_{DS}}{C_{ox}} \frac{df}{f}$$

$$\overline{i^2_{n_{1/f}}} = \frac{K_1}{L^2} \frac{I_{DS}}{C_{ox}} \ln(f_2/f_1)$$

$$\overline{i^2_{n_{1/f}}} = \frac{K_2}{L^2} \frac{I_{DS}}{C_{ox}} \log(f_2/f_1)$$

We also know that Thermal Noise ~~Voltage~~ current in a frequency band can be written as

$$\overline{i^2_{n_{th}}} = 4kT\left(\frac{2}{3} g_m\right)$$

At a frequency f_c called <u>1/f Noise Corner frequency</u> the two noise voltages are equal

or $$4kT\left(\frac{2}{3} g_m\right) = \frac{K}{C_{ox} W \cdot L} \cdot \frac{1}{f_c} g_m^2$$

or $$f_c = \frac{K g_m}{C_{ox} W \cdot L} \frac{3}{8kT}$$