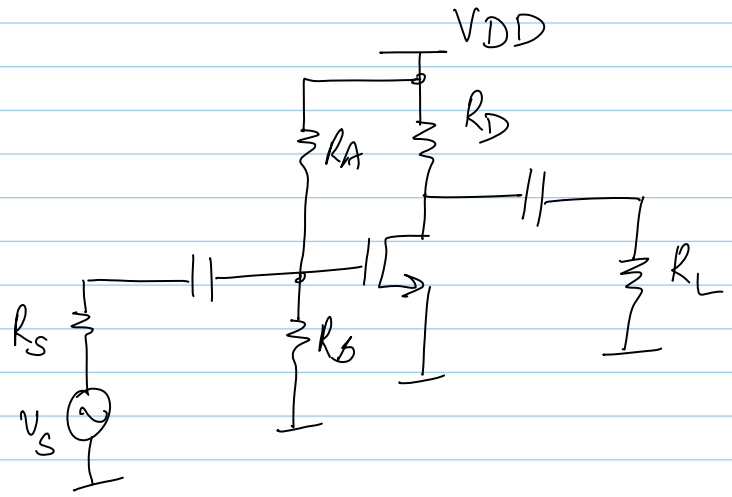
28.8.12

Lec 14



We know
* How this ckt came about
* Gain
* Swing limits

Issues
* Non-linearity → swing limits
* ∞ caps → large caps would do
* Tolerances : e.g. $R_A = 1.5M\Omega \pm 5\%$

M1 : μ_n, C_{ox}, $\frac{W}{L}$, V_T

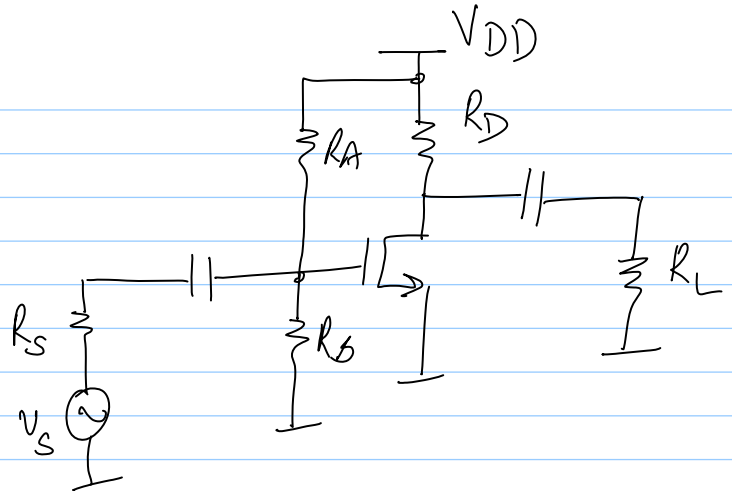
→ Vary with
* ambient conditions (temp. etc.)
* time

→ Cannot guarantee $V_{T1} = V_{T2}$ for M_1 & M_2, for example
i.e. random variations in device properties

If V_T changes ⇒ I_D will change,
V_{Dsat} etc. will also change

On an IC ⇒ multiple copies of same devices have same properties
→ but change over different IC fabrications
→ Ratios of like components vary similarly
e.g. $R_A = 1.5M\Omega$, $R_B = 3.5M\Omega$
If $R_A \rightarrow +10\%$, $R_B \rightarrow +10\%$.
⇒ $\frac{R_B}{R_A + R_B}$ varies much lesser than 10 %.

Ratios of similar components well controlled



Problems
1) Bias current varies with V_T
⇒ Swings & inc. gain dependent on V_T

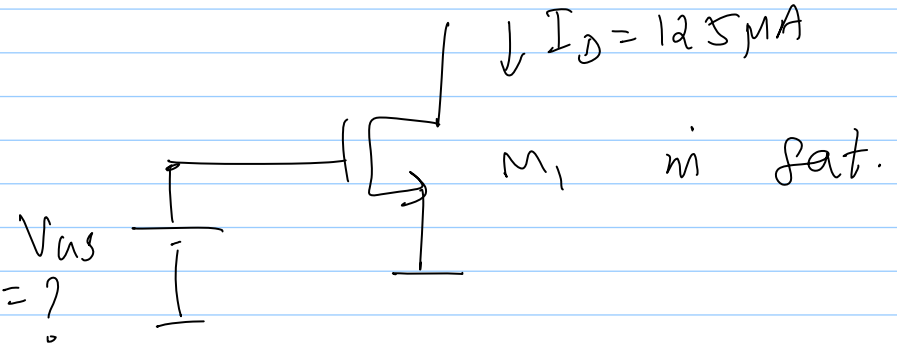
→ V_{GS} is fixed, but V_T varies

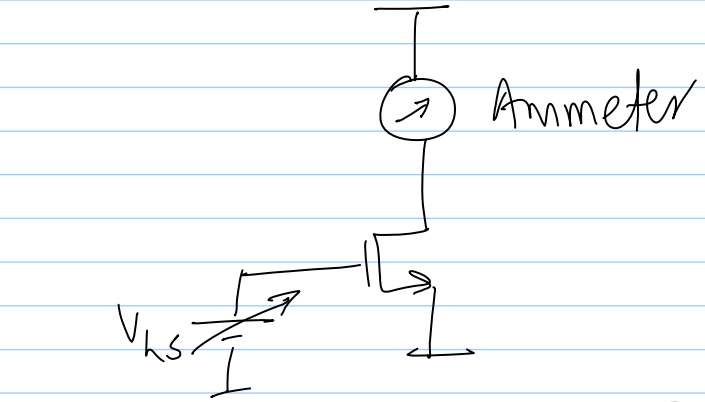
Solutions:
1) If we know V_T, make V_{GS} track V_T change i.e. make $(V_{GS} - V_T)$ constant based on current we want

So far: apply V_{GS}, create I_D based on V_T etc.

Now: figure out what V_{GS} is to be applied for a certain I_D

e.g. $I_D = 100\,\mu A$, $V_{GS1} - V_T = 0.5V$





independent of device characteristics

* Apply V_{GS}
* measure I_D
* If $I_D > 100\mu A$, $V_{GS} > V_{GS1}$
  ⇒ reduce V_{GS}
* If $I_D < 100\mu A$, $V_{GS} < V_{GS1}$
  ⇒ increase V_{GS}

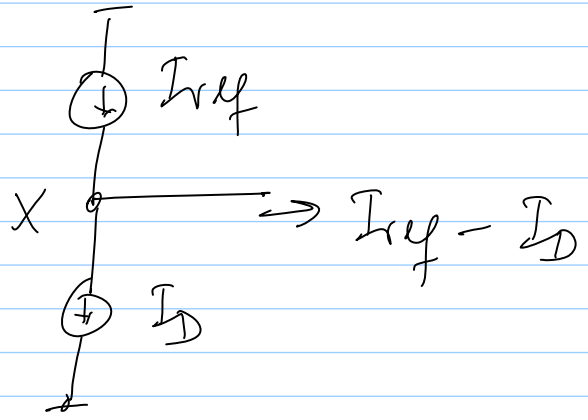
⇒ Negative Feedback

open loop method:

$V_{GS_1} \rightarrow I_{D_1}$
$V_{GS_2} \rightarrow I_{D_2}$
) Solve device equations to get $\mu_n C_{ox}$ & V_T

100μA ⇒ reference quantity
actual I_D ⇒ output quantity
use the error $(I_D - 100\mu A)$ = difference between output & reference to tweak input (V_{GS})

$(I_{ref} - I_D)$ = comparing I_{ref} & I_D



If $I_{ref} = I_D$, V_X can be anything, but since no charge is added/removed, V_X does not change!

* If $I_{ref} > I_D$, V_x ↑ with time

* $I_{ref} < I_D$, V_x ↓ with time