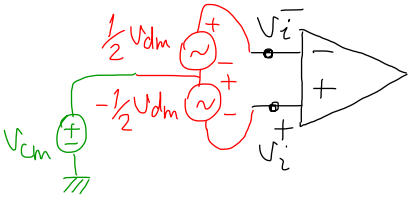
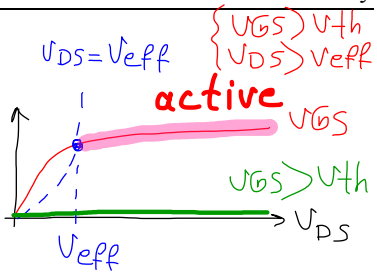
* Voltage swing of diff-pair amplifiers :



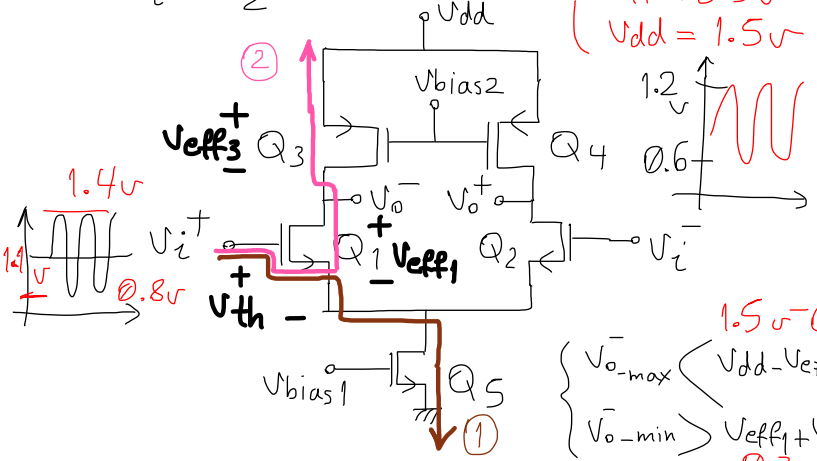
$$V_i^- = \frac{1}{2}V_{dm} + V_{cm}$$

$$V_i^+ = -\frac{1}{2}V_{dm} + V_{cm}$$



Veff (effective voltage)
((Vov (overdrive voltage)

* Assume
{ Vth = 0.5 V
{ Veff = 0.3 V
{ Vdd = 1.5 V



* Veff is the minimum voltage across drain/source terminals so that transistor operates in the active

* Vth is the voltage that depletes the channel and makes it ready for inversion

* look for conditions that keep all transistors in a circuit in the active region

$$\begin{cases} V_{o\_max} < V_{dd} - V_{eff3} \\ V_{o\_min} > V_{eff1} + V_{eff5} \end{cases}$$

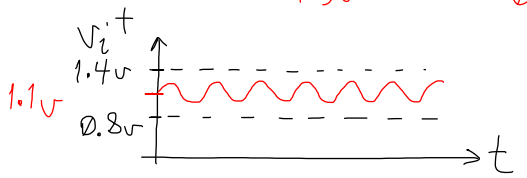
1.5 V − 0.3 V

0.3 + 0.3

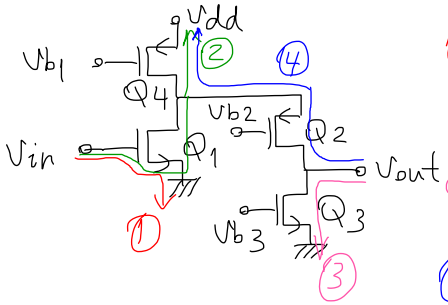
(1) $V_{i\,min}^+ > V_{GS1} + V_{DS5} \Rightarrow V_{i\,min}^+ > 0.8\ V$

(2) $V_{i\,max}^+ < V_{dd} - V_{SD3} - V_{SD1} + V_{GS1} \Rightarrow V_{i\,max}^+ < 1.4\ V$

1.5 V, 0.3, 0.3, 0.5



{ Vdd = 1.5 V, Vth = 0.5 V, Veff = 0.3 V
{ Av0 = 20 V/V

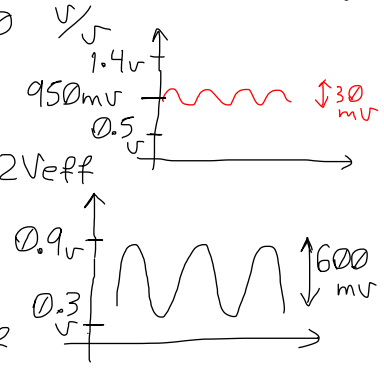


(1) $V_{in-min} > V_{th}$

(2) $V_{in-max} < V_{dd} + V_{th} - 2V_{eff}$

(3) $V_{out-min} > V_{eff}$

(4) $V_{out-max} < V_{dd} - 2V_{eff}$



$$A_{v0} = -g_{m1}\left(r_{ds1} \| r_{ds3}\right)$$
$$= -10 \ V/V$$