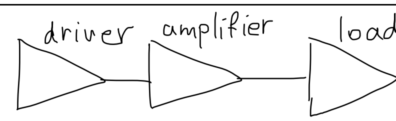
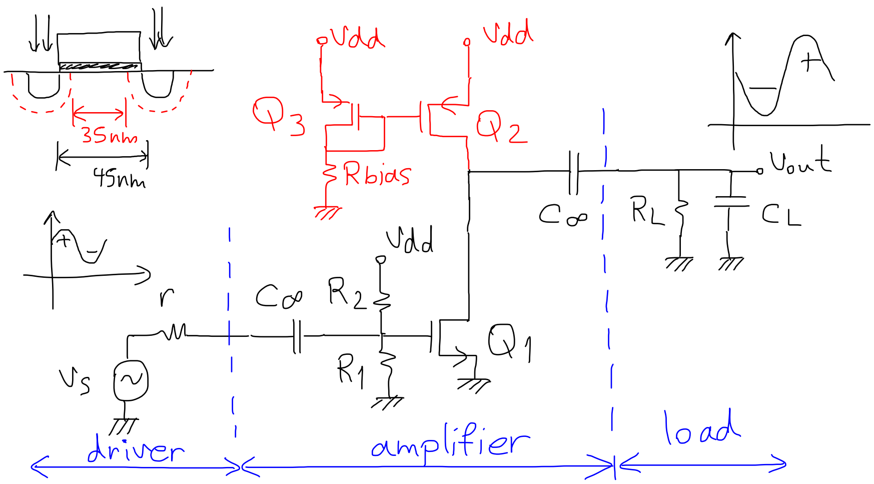
* Common source amplifiers :





W_i	$10\mu m$
L_i	$45nm$
V_{th}	$0.3v$
λ	$0.01\ [1/v]$
$\mu_n C_{ox}$	$200\mu\ [A/v^2]$
$\mu_p C_{ox}$	$50\mu\ [A/v^2]$
V_{dd}	$1.5v$
P_{DC}	$< 2mW$

$$P_{DC} = \underbrace{V_{dd}}_{1.5v}\underbrace{(I_{ref} + I_o)}_{1.4mA} \quad ; \quad I_{ref} < I_o$$

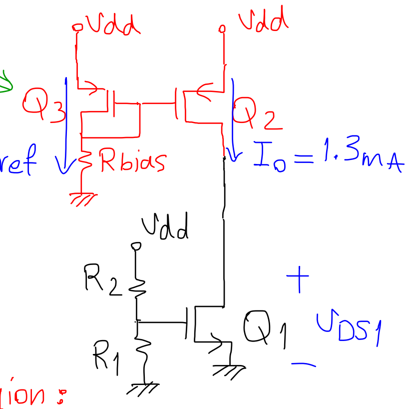
* DC Analysis :

Q_3 : active :

$$\begin{cases} I_{SD3} = \frac{1}{2}\mu_p C_{ox}\frac{W_3}{L_3}(V_{SG3}-V_{th})^2\left[1+\lambda V_{th}\right] \\ V_{dd} = V_{SG3} + R_{bias} I_{SD3} \end{cases}$$

$\Longrightarrow$ find I_{SD3} and $V_{SG3} = V_{SG2}$

can have minimum width in technology



$$\frac{I_o}{I_{ref}} \approx \frac{W_2}{W_3} \quad \text{if } L_2 = L_3 \text{ and } \lambda \text{ very small}$$

* Assume Q_1 is biased in the active region :

$$I_{DS1} = I_o = \frac{1}{2}\mu_n C_{ox}\frac{W_1}{L_1}(\underline{V_{GS1}} - V_{th})^2\left[1+\lambda(\underline{V_{DS1}} - (V_{GS1}-V_{th}))\right]$$

$$V_{GS1} = V_{dd}\frac{R_1}{R_1+R_2} > V_{th}$$

$$V_{dd} = V_{SD2} + V_{DS1}$$

$$I_{SD2} = \frac{1}{2}\mu_p C_{ox}\frac{W_2}{L_2}(V_{SG2}-V_{th})^2\left[1+\lambda(\underline{V_{SD2}} - (V_{SG2}-V_{th}))\right]$$

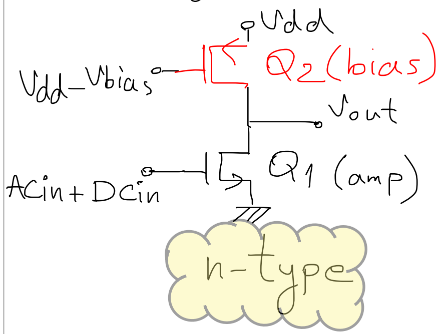
find V_{SD2} and V_{DS1}

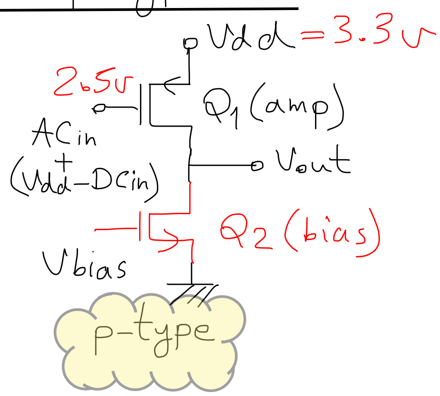
* Verify if Q_1 is operating in the active region :

$$\begin{cases} V_{DS1} > V_{GS1} - V_{th} \\ V_{GS1} > V_{th} \end{cases}$$

$$g_{m1} = \mu_n C_{ox}\frac{W_1}{L_1}(V_{GS1} - V_{th}) \quad \text{and} \quad r_{ds1} = \frac{1}{\lambda I_{DS1}}$$

n-type C.S ⟶ p-type C.S





1. n-type ⇄ p-type
2. ⏚ ⇄ Vdd
3. Vbias ⇄ Vdd−Vbias
4. keep terminal connections unchanged