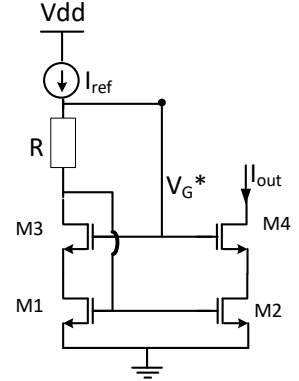


Série N3: Current sources and mirrors

nMOS: $k_{p,n} = 184 \mu\text{A/V}^2$; $V_{Tn} = 0.3 \text{ V}$; $U_{a,N} = 4.6 \text{ V}/\mu\text{m}$, $n=1.2$ pMOS: $k_{p,p} = 43 \mu\text{A/V}^2$; $V_{Tp} = 0.45 \text{ V}$; $U_{a,P} = 12.5 \text{ V}/\mu\text{m}$; $n=1.3$

Exercise N1 : Self Biasing wide swing current mirror

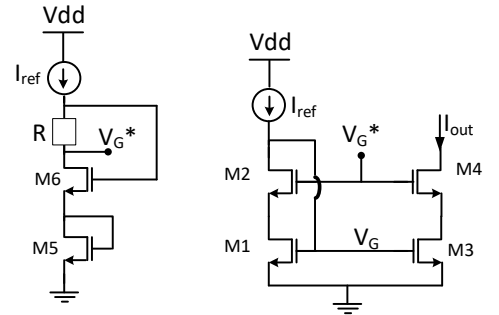
1. Determine R for a maximum output dynamic range.
2. Determine the minimum and maximum values of $R \cdot I_{ref}$ such that both M1 and M3 remains in saturation.



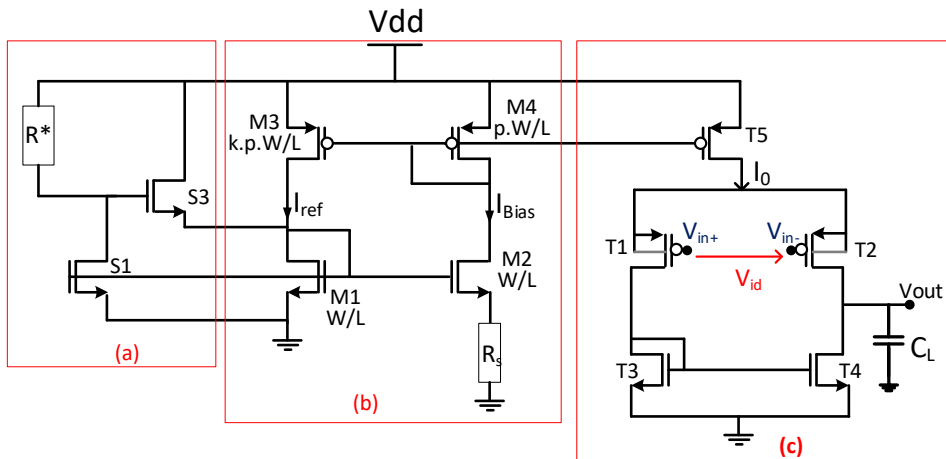
Exercise N2 : Wide swing current mirror

$(W/L)_{1,2,6,5} = 20/1$, $(W/L)_{3,4} = 60/1$, $I_{ref} = I_1 = 100 \mu\text{A}$

1. Determine V_G , V_G^* and R for a maximum output dynamic range.
2. Estimate the deviation of I_{out} from 300 μA if the drain voltage of M4 is higher than V_G by 1V.



Exercise N3 : Biasing circuits (β -Multiplier)



1. Explain the operation of (a).
2. Explain the operation of (b) and size all its transistors and R_s to meet the following specifications: $I_{BIAS} = 10 \mu\text{A}$, $V_{ov,n1} = V_{ov,p} = 0.2 \text{ V}$ and $k=4$.
3. If the all nMOS transistors of (a) and (b) have the same size, propose a value for R^* .