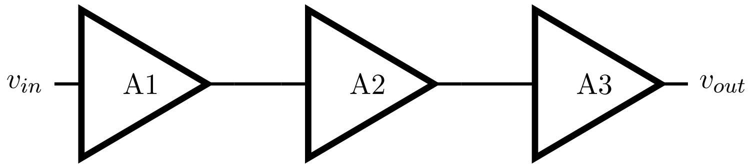
# Exercícios TE329

Parte 1

1. Especifique configurações amplificadoras de múltiplos estágios de forma que:
   (a) Seja um bom amplificador de tensão;
   (b) Seja um bom amplificador de corrente;
   (c) Seja um bom amplificador de transcondutância;
2. Para as configurações listadas abaixo, o que pode se dizer sobre $R_{in}$, $R_{out}$, $A_{v0}$ e $G_m$?
   (a) Estágio fonte comum seguido de um estágio fonte comum;
   (b) Estágio Porta comum seguido de um estágio Dreno comum;
   (c) Estágio porta comum seguido de um estágio emissor comum;
   (d) Estágio fonte comum seguido de um estágio dreno comum;
3. Considere os circuitos das figuras abaixo, obtenha os valores de $R_{in}$, $R_{out}$ e $A_{v0}$ de um amplificador de tensão equivalente:

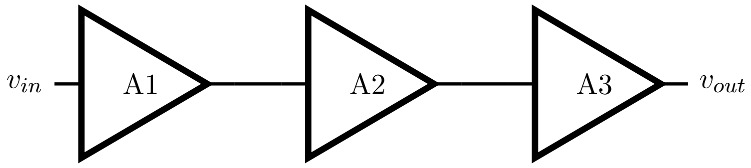
(a) 


Considere:

| | A1 | A2 | A3 |
|---|---|---|---|
| $R_{in}$ | 1 kΩ | 100 kΩ | 10 kΩ |
| $R_{out}$ | 10 kΩ | 1 kΩ | 100 Ω |
| $A_{v0}$ | -10 V/V | 20 V/V | 0.8 V/V |

Resposta: $R_{in} = 1$ kΩ, $R_{out} = 100$ Ω, $A_{v0} = -132$ V/V.

---

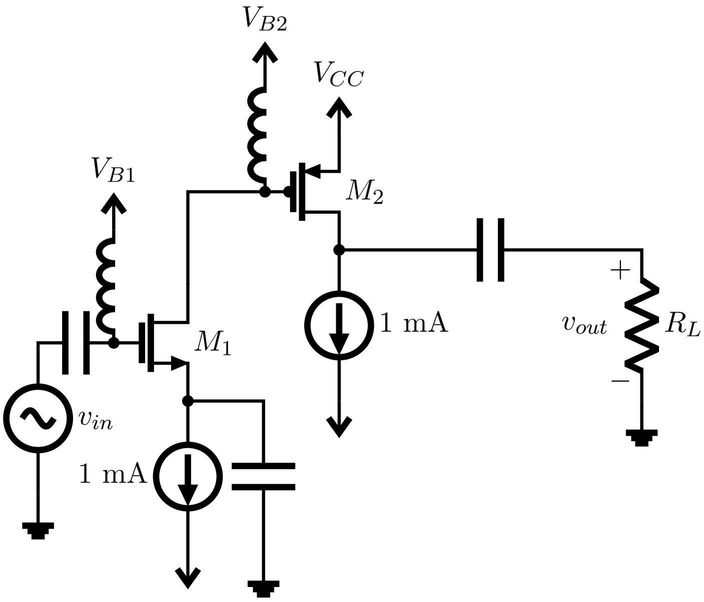
(b) 


Considere:

| | A1 | A2 | A3 |
|---|---|---|---|
| $R_{in}$ | 1 MΩ | 10 kΩ | 1 kΩ |
| $R_{out}$ | 10 kΩ | 100 kΩ | 100 kΩ |
| | $A_{v0} = 10$ V/V | $G_m = 2$ mA/V | $A_{is} = -10$ A/A |

Resposta: $R_{in} = 1$ MΩ, $R_{out} = 100$ kΩ, $A_{v0} = -9901$ V/V.

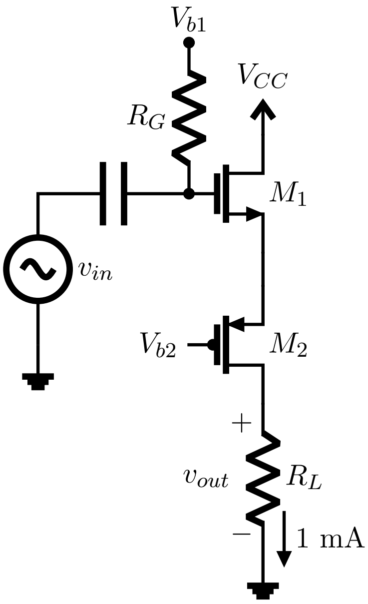
---




(c) Considere $\mu_n C_{ox} W/L = 2$ mA/V² e $\lambda = 0.1$ V$^{-1}$

Resposta: $R_{in} = \infty$, $R_{out} = 10$ kΩ, $A_{v0} = 400$ V/V.

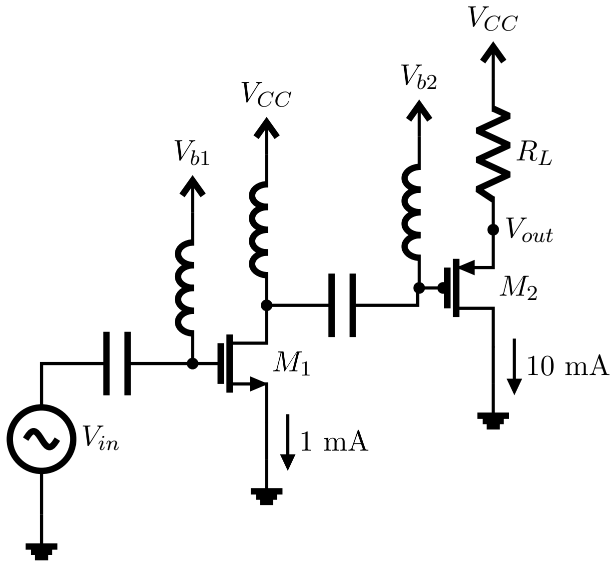
---




(d) Considere $\mu_n C_{ox} W/L = 2$ mA/V², $\mu_p C_{ox} W/L = 1.5$ mA/V², $\lambda = 0.1$ V$^{-1}$ e $R_G = 1$ MΩ.

Resposta: $R_{in} = 1$ MΩ, $R_{out} = 220$ kΩ, $A_{v0} = -440$ V/V.

---

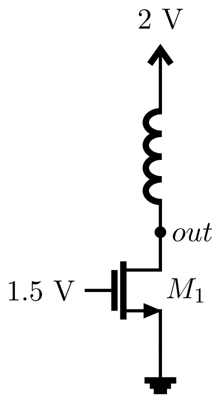
(e) 


Considere $\mu_n C_{ox} W/L = 2$ mA/V², $\mu_p C_{ox} W/L = 1.5$ mA/V² e $\lambda = 0.1$ V$^{-1}$.

Resposta: $R_{in} = \infty$, $R_{out} = 183\ \Omega$, $A_{v0} = -20$ V/V.

---

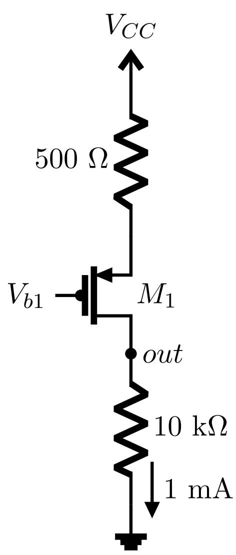
4. Obtenha a resistência equivalente vista do terminal *out* dos circuitos:

(a) 


$\lambda = 0.2$ V$^{-1}$
$V_t = 0.5$ V
$\mu_n C_{ox} W/L = 2$ mA/V²

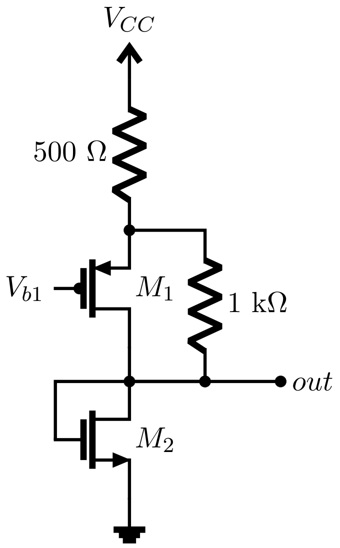
Resposta: $R_{out} = 3571\ \Omega$.

---

(b) 


$\lambda = 0.05$ V$^{-1}$
$\mu_p C_{ox} W/L = 2$ mA/V²

Resposta: $R_{out} = 6.7$ kΩ.

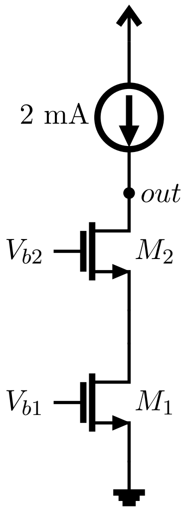



$g_{m1} = g_{m2} = 1.5$ mA/V
$r_{o1} = r_{o2} = 5$ kΩ

(c)

Resposta: $R_{out} = 303\ \Omega$.

---

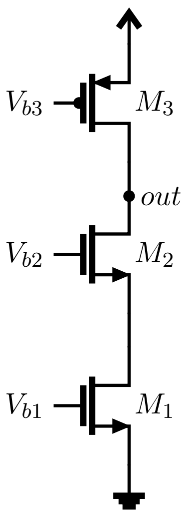



$r_{o1} = 2$ kΩ
$r_{o2} = 3$ kΩ
$g_{m1} = 1.5$ mA/V
$g_{m2} = 2$ mA/V

(d)

Resposta: $R_{out} = 12$ kΩ.

---



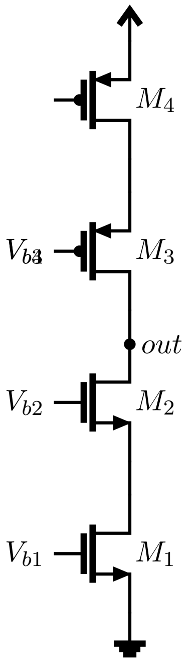

$r_{o1} = 2$ kΩ
$r_{o2} = 3$ kΩ
$r_{o3} = 4$ kΩ
$g_{m1} = 1.5$ mA/V
$g_{m2} = 2$ mA/V
$g_{m3} = 1.2$ mA/V

(e)

Resposta: $R_{out} = 3$ kΩ.

---

(f)

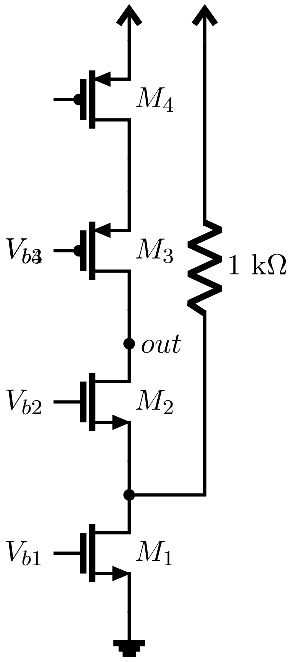



$r_{o1} = 2$ kΩ
$r_{o2} = 3$ kΩ
$r_{o3} = 4$ kΩ
$r_{o4} = 3.5$ kΩ
$g_{m1} = 1.5$ mA/V
$g_{m2} = 2$ mA/V
$g_{m3} = 1.2$ mA/V
$g_{m4} = 0.9$ mA/V

Resposta: $R_{out} = 7$ kΩ.

---

(g)

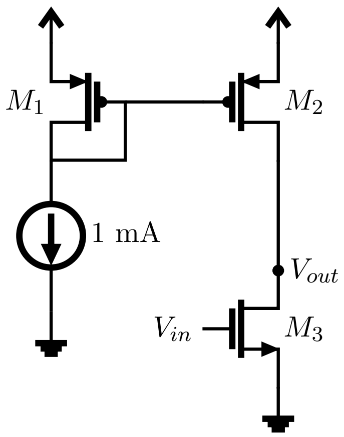



$r_{o1} = 2$ kΩ
$r_{o2} = 3$ kΩ
$r_{o3} = 4$ kΩ
$r_{o4} = 3.5$ kΩ
$g_{m1} = 1.5$ mA/V
$g_{m2} = 2$ mA/V
$g_{m3} = 1.2$ mA/V
$g_{m4} = 0.9$ mA/V

Resposta: $R_{out} = 3.2$ kΩ.

---

5. Calcule o ganho de tensão em aberto dos circuitos abaixo:

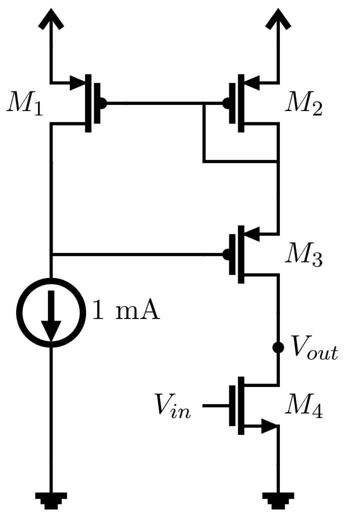



$\mu_n Cox = 0.2$ mA/V2
$\mu_p Cox = 0.15$ mA/V2
$L = 0.1\ \mu$m
$W_1 = 0.5\ \mu$m
$W_2 = 1.5\ \mu$m
$W_3 = 1\ \mu$m
$\lambda_p = 0.12$ V$^{-1}$
$\lambda_n = 0.09$ V$^{-1}$

(a)

Resposta: $A_{v0} = -5.5$ V/V.

---

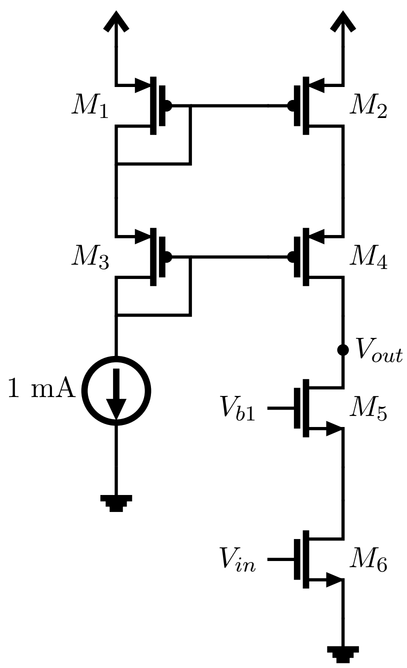



$\mu_n Cox = 0.2$ mA/V2
$\mu_p Cox = 0.15$ mA/V2
$L = 0.1\ \mu$m
$W_1 = 0.5\ \mu$m
$W_2 = 1.5\ \mu$m
$W_3 = 1.5\ \mu$m
$W_4 = 1\ \mu$m
$\lambda_p = 0.12$ V$^{-1}$
$\lambda_n = 0.09$ V$^{-1}$

(b)

Resposta: $A_{v0} = -12.3$ V/V.

---

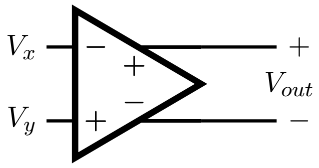



$\mu_n Cox = 0.2$ mA/V2
$\mu_p Cox = 0.15$ mA/V2
$L = 0.1\ \mu$m
$W_1 = 0.5\ \mu$m
$W_2 = 1.5\ \mu$m
$W_3 = 1.5\ \mu$m
$W_4 = 1.5\ \mu$m
$W_5 = 1\ \mu$m
$W_6 = 1\ \mu$m
$\lambda_p = 0.12$ V$^{-1}$
$\lambda_n = 0.09$ V$^{-1}$

(c)

Resposta: $A_{v0} = -61.5$ V/V.

6. Considere o circuito da figura abaixo e responda

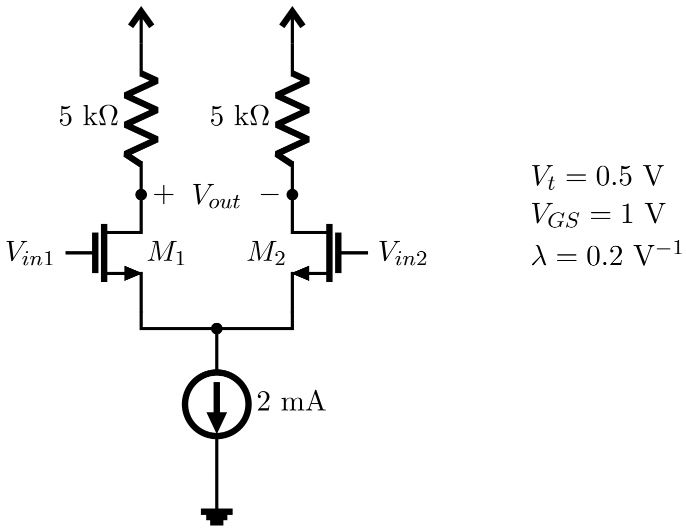



(a) Seja $V_x = \sin(\omega t)$, $V_y = -\sin(\omega t)$, $A_{v0} = 10$ V/V. Qual será o sinal de saída?

(b) Se $V_x = 2 + \sin(\omega t + \pi)$, $V_y = 2 + \sin(\omega t)$, $A_{v0} = 2$ V/V, Qual será o sinal de saída?

(c) Ao inserir $V_y = 0.05\sin(\omega t) + 2$ e $V_y = -0.05\sin(\omega t) + 2$, observa-se $V_{out} = 10\sin(\omega t) + 0.01$. Qual é o ganho diferencial e CMRR. CMRR = 20000

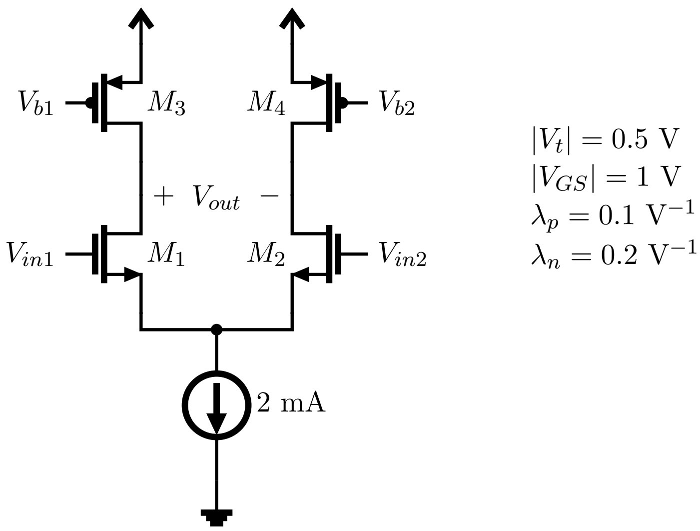
7. Para os circuitos das figuras abaixo obtenha $A_{v0}$, $R_{in}$ e $R_{out}$.




(a)

Resposta: $R_{in} = \infty$, $R_{out} = 5$ kΩ, $A_{v0} = -10$ V/V.

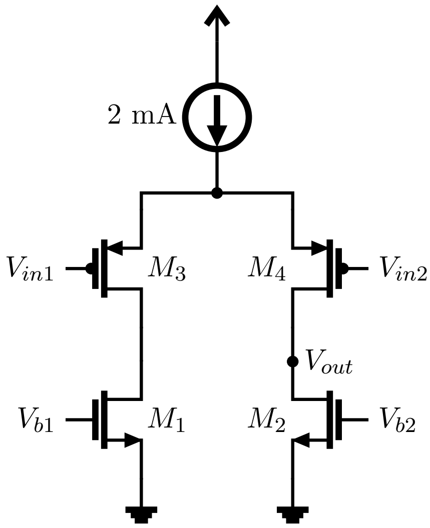
---




(b)

Resposta: $R_{in} = \infty$, $R_{out} = 6.7$ kΩ, $A_{v0} = -13.3$ V/V.

---

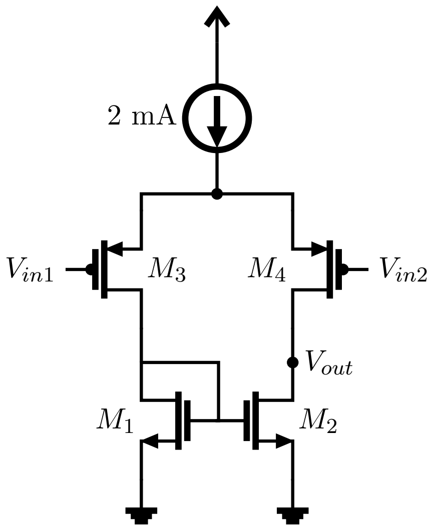



$\mu_p C_{ox} W/L = 1.5$ mA/V²
$\mu_n C_{ox} W/L = 2$ mA/V²
$\lambda_p = 0.1$ V$^{-1}$
$\lambda_n = 0.2$ V$^{-1}$

(c)

Resposta: $R_{in} = \infty$, $R_{out} = 3.3$ kΩ, $A_{v0} = -2.9$ V/V.

---




$\mu_p C_{ox} W/L = 1.5$ mA/V²
$\mu_n C_{ox} W/L = 2$ mA/V²
$\lambda_p = 0.1$ V$^{-1}$
$\lambda_n = 0.2$ V$^{-1}$

(d)

Resposta: $R_{in} = \infty$, $R_{out} = 3.3$ kΩ, $A_{v0} = 5.8$ V/V.

---