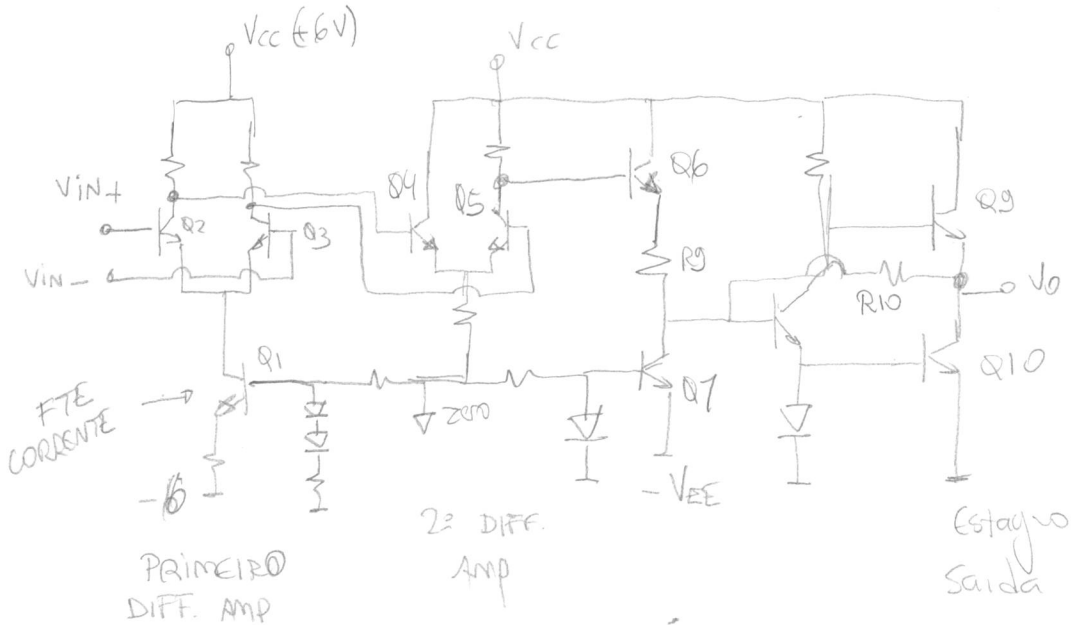


AMPLIFICAR OPAMP REAL
MC 1530

Mullman Halkins



- Q1 → FTE corrente
- Q2 - Q3 - diff amp $A_{V1} = .60$
- Q4 - Q5 - 2º estágio diff amp. $A_{V2} = -29$
- Q6 → coletor comum

R9 - R10 : feedback interno (anostra tensão) $A_4 \approx -\frac{R_{10}}{R_9} = -5$
 (compensação corrente)

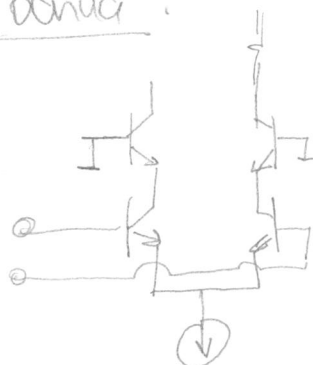
$A_{TOTAL} = .60 \times -28.9 \times -5 = 8670$

Q9 - Q10 → coletor comum

Perceba → AMPLIFICA DC (TODOS OPAMP AMPLIFICAM DC !)

P/ Aumentar banda :

uso Cascode



P/ aumentar Z_{IN} e banda
 MOSFET custo!

Ideal BiCMOS
 MOSFET + BIPOLAR
 ↓ ↓
 ALTO Z_{IN} ALTOS GANHOS

ACTIVE LOAD

(Grebene)

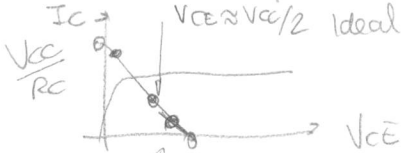
$$A_V = -g_m R_C = -\frac{I_C R_C}{V_T}$$

$$-\frac{R_C}{h_{ie}} = -\frac{R_C}{\frac{V_T}{I_C}}$$

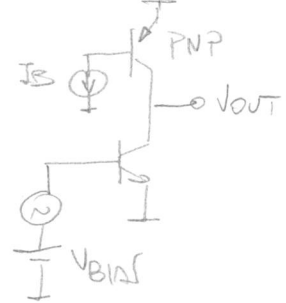
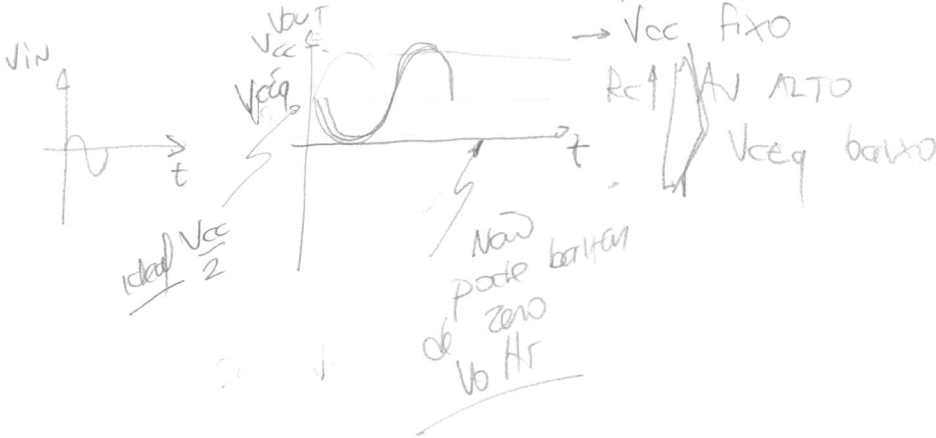
PI GANHO SER

ALTO FAÇO $R_C \uparrow$

MAS ASSIM PTO. Q MUDA



$V_{CE} = V_{CC} - I_C R_C \rightarrow I_C$ definido p/ base ($I_E = I_C / \beta$)
 se $R_C \uparrow V_{CE} \rightarrow$ ZERO
 $\rightarrow R_C$ fixo
 $\rightarrow V_{CC}$ fixo



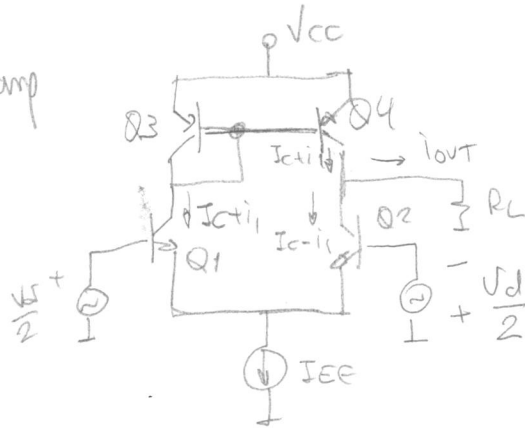
dynamic resistance of a transistor

$$A_V = -g_m (r_{oi} \parallel r_{oe})$$

resist. interna de saída



Uso pratico opamp

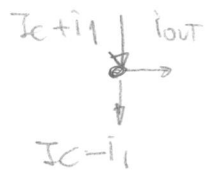


transistores casados $\beta \gg 1$
 se $V_d = 0 I_C = I_{EE}/2$

se V_d pequeno aparece a corrente no Q1 sobe e no Q2 cai



mas Q3 (ligado como diodo) FAZ a corrente nos 2 lados ser igual (V_{be} nos Q3 e Q1 e igual), ou seja.

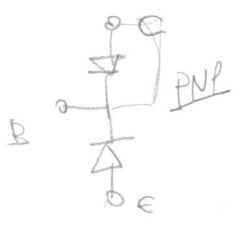


$$i_{OUT} = I_C + i_1 - (I_C - i_1) = 2i_1$$

$$\bar{I}_1 = g_m \frac{V_{id}}{2} = \frac{I_{EE}}{2V_T} V_{id}$$

$$i_{OUT} = 2g_m \frac{V_d}{2} = g_m V_d$$

*** Q3 → diodo



$$R_{OUT} = r_{o2} \parallel r_{o4}$$



$$A_{V_{MAX}} = \frac{i_{OUT} R_{OUT}}{V_{id}} : \text{ganho ordem } 60 \text{ dB (ou } 1000) !$$