Question 0:

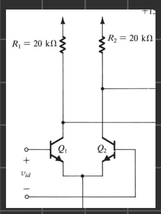
emetteur commun $A_{vo} = -g_m R_c$

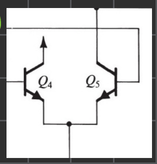
monter en diode $Z = 1/g_m$

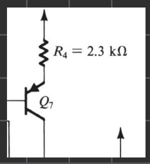
$A_{vo} = -g_m\left(\frac{1}{g_m}\right) = -1$

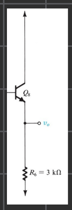
$A_{vo} = -1$

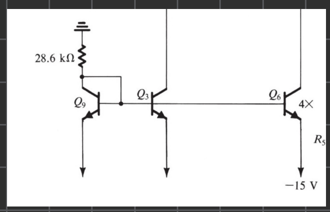
Question 1:

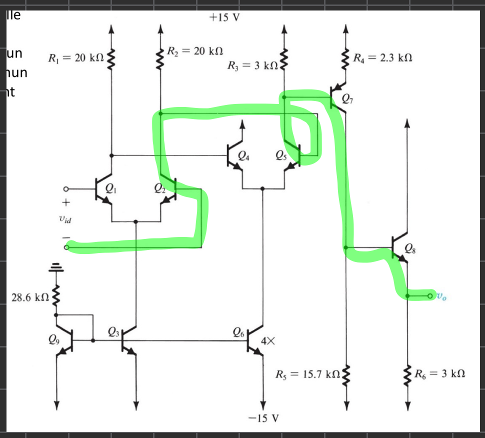
a) 

b) 

c) 

d) 

e) 

f) 

g) Q_4 et $Q_5 = V_{PP} - V_{R_1}$

$Q_7 = V_{PP} - V_{R_3}$

Question 2

a) $I_{C6} = 5\,mA$

$I_{C5} = I_{C6} = 5\,mA$

$I_{C1} = I_{C2} = \frac{1}{2} I_{C6} = 2.5\,mA$

I_{C7} = mirror à Q_3 = $2.5\,mA$

I_{C9} = mirror à Q_4 = $2.5\,mA$

b) différentiel

$\frac{|V_A|}{I_C}$ $\quad 1/g_m = \frac{V_T}{I_C}$

$Z_B = r_\pi + (B+1)\left[R_{EE} \,//\, (r_o + R_{cc})\right]$

on peut neglige R_{cc}, car $V_A \gg V_T$

$Z_B = r_\pi + (B+1)\left[R_{EE} \,//\, r_o\right]$

on peut negliger Z_{cas} car $r_{oc} \gg Z_E Q_2$

$R_{EE} = \frac{r_\pi + R_{BB}}{(B+1)} \,||\, r_o$

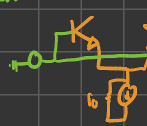
$R_{BB} = 0$ $\quad \frac{r_\pi}{(B+1)} = r_e$ $\quad$ et $r_e \ll r_o$ donc on neglige r_o

$R_{EE} = \frac{r_\pi}{(B+1)}$

$Z_{B\,diff} = r_\pi + (B+1)\frac{r_\pi}{(B+1)}$

$Z_{B\,diff} = 2r_\pi = 2\frac{V_T}{I_B} = 2\cdot\frac{0.0256}{\frac{0.025}{150}} = 3.072\,k\Omega$

Commun



étant donné que commun on sait que deux buts sont parrel donc on peut analyser un bout · 0.5 car on reste des deux buts

$Z_{in} = \frac{1}{2}\left(r_\pi + (B+1)\left[R_{EE} \,||\, (r_o + R_{cc})\right]\right)$

neglige

$\frac{1}{2}\left(r_\pi + (B+1)\left((B+1) r_o \,||\, (r_o + 1/g_m)\right)\right)$

$(B+1) r_o \gg r_o$ donc on neglige

$\frac{1}{2}\left(r_\pi + (B+1) r_o\right)$

$\frac{1}{2} B r_o$

Q_5

$r_o\left[1 + g_m(r_\pi \,||\, R_{EE})\right] + (r_\pi \,||\, R_{EE})$

Q_6

$r_o\left[1 + g_m(r_\pi \,||\, r_o)\right] + (r_\pi \,||\, r_o)$

on peut neglige r_o $\quad r_o \gg r_\pi$

on neglige r_π

$r_o + g_m r_o r_\pi + r_\pi$

$g_m = \frac{B}{r_\pi}$

$r_o + \frac{B}{r_\pi} r_o r_\pi + r_\pi$

$r_o(B+1)$

c) $Z_{out} = r_{on} \,//\, r_{op}$

$$\frac{1}{\frac{0.0025}{30} \quad \frac{0.0025}{100}} = 9230\ \Omega$$

d) $10\text{ V} - 0.2\text{V} - 0.2\text{V} = 19.6\text{ V}$

c)

Question 3 :

$$Z_0 = r_0 + R_{EE}\left[\frac{r_\pi + R_{BB} + r_\pi r_o g_m}{r_\pi + R_{BB} + R_{EE}}\right]$$

$R_{BB} = {}^1/_{g_m}$ Car en date

$R_{EE} = {}^1/_{g_m}$ Car en date

$$= r_0 + {}^1/_{g_m}\left[\frac{r_\pi + {}^1/_{g_m} + r_\pi r_o g_m}{r_\pi + {}^1/_{g_m} + {}^1/_{g_m}}\right]$$

$$= r_0 + {}^1/_{g_m}\left[\frac{r_\pi\left(1 + \frac{1}{\beta} + \frac{2r_o}{\beta}\right)}{r_\pi\left(1 + \frac{1}{\beta} + \frac{1}{\beta}\right)}\right]$$

$$= r_0 + \frac{1}{g_m}\left[\frac{1 + \frac{1}{\beta} + \frac{2r_o}{\beta}}{1 + \frac{2}{\beta}}\right]$$

$r_0 = \frac{V_A}{I_C}$ $\qquad g_m = \frac{\beta}{r_\pi}$

$$= \frac{40}{100\cdot10^{-6}} + \frac{1}{\left(\frac{75}{\left(\frac{0.0025}{\left(\frac{100\cdot10^{-6}}{75}\right)}\right)}\right)}\left[\frac{1 + \frac{1}{75} + \frac{2\left(\frac{40}{100\cdot10^{-6}}\right)}{75}}{1 + \frac{2}{75}}\right]$$

$$= 400\,000 + 25\left[\frac{1 + \frac{1}{75} + 10\,666.667}{1 + \frac{2}{75}}\right]$$

$$= 400\,000 + 25 \cdot 10\,390.59$$

$$= 400\,000 + 259\,764$$

$$= 659\,764.94$$

Question 4:

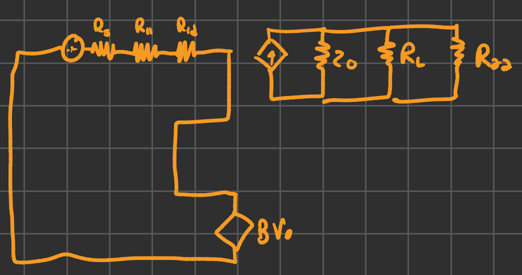
a) $\frac{V_o}{V_s}$ = Voltage = serie-shunt

$R_{11} = R_1 // R_2$

$R_{22} = R_1 + R_2$

$A_i = \frac{\mu V_i}{Z_o}$

$B = \frac{R_2}{R_1 + R_2}$



Question 5:

Marge de gain d'au moins 10 dB

Question 8:

$Z_1 = \dfrac{R_{11}}{(1-B)}$ $\qquad$ $Z_2 = \dfrac{R_{22}}{\left(1-\frac{1}{B}\right)}$

$Z_1 = (1-K)R$ $\qquad$ $R_{22} = (1-K)R\left(1-\frac{1}{B}\right)$

$(1-K)R = \dfrac{R_{11}}{(1-B)}$

$R_{11} = (1-K)R(1-B)$

Question 5:

Augementer marge gain

r_o

r_c

r_e

$r_{oQ_4} // r_{eQ_1} // r_{cQ_3}$

Prise 2

Question 0

Emetteur commun + diode

$A_v = -g_m R_e$ $\quad Z = 1/g_m$

$A_v = -g_m \frac{1}{g_m}$

$A_v = -1$

Question 1

a) $Q_1 - Q_2$, $Q_4 - Q_5$

b) Q

c) Q_1, Q_2, Q_4, Q_5, Q_7

d) Q_8

e) $Q_9 - Q_3 - Q_6$

f) $Q_2 - Q_5 - Q_7 - Q_8$

g) $\frac{I_{C Q_1}}{2} = I_{C Q_4} = \frac{-15 + 0{,}7}{28.6K} = 0{,}5\ mA$

$V_{B Q_4} = V_{BQ_5} = 15 - V_{R_1(2)} = 15 - 20000(0.00025) = 10V$

$V_B = \frac{0.0005 \cdot 4}{2}$ car $4x$ $= \frac{2mA}{2} = 1mA$ $= 15 - 3000\ (0.001) = 12V$

Question 2

a) $I_{Q_6} = 5mA$

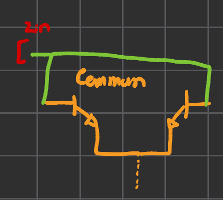
$I_{Q_5} = 5mA$

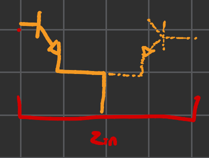
$I_{Q_1 - Q_2 - Q_3 - Q_4} = \frac{I_{C Q_6}}{2} = 2.5mA$

$I_{Q_7 - Q_9} = I_{C Q_4 - Q_3} = 2.5mA$

$I_{Q_8 - Q_0} = I_{Q_7 - Q_9} = 2.5mA$

b)





$Z_{in} = Z_{v_1} // Z_{v_2}$

$Z_{in} = \frac{Z_v}{2}$

$Z_v = r_\pi + (\beta + 1)\ (R_{EE} // r_o + R_{cc})$ ∞ car ignoré, 0 car ignoré

$r_\pi + (\beta + 1)\ r_o$

$Z_{in} = \frac{r_\pi + (\beta + 1) r_o}{2}$

$Z_{in} = Z_{B_4} +$ mos writed $+ Z_{B_2}$

Question 3

$Z_o = Z_{c Q_4}$

$Z_o = r_o + R_{EE} \left[\frac{r_\pi + R_{BB} + r_\pi r_o g_m}{r_\pi + R_{BB} + R_{EE}} \right]$ $\quad R_{BB} = 1/g_m$, $R_{EE} = 1/g_m$

$g_m = \frac{100 \cdot 10^{-6}}{0.025} = 0.004$

$r_\pi = \frac{0.025 \cdot 75}{100 \cdot 10^{-6}} = 18750$

$Z_o = 5333 + 250 \left[\frac{18750 + 250 + (18750 \cdot 400000 \cdot 0.004)}{18750 + 250 + 250} \right]$

$r_o = \frac{40}{100 \cdot 10^{-6}} = 400K$

$Z_o = 394\ 970$

Question 4

a) $R_{11} = R_1 // R_2$

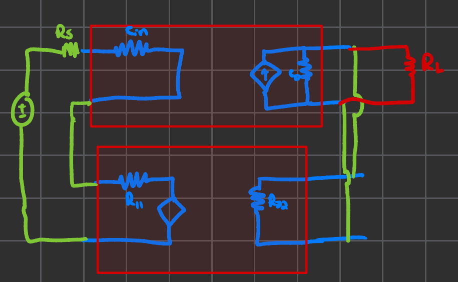
$R_{22} = R_1 + R_2$

$B = \frac{R_2}{R_1 + R_2}$

$A_i = \frac{\mu V_i}{Z_o}$

$R_{of} = R_L // R_{22} // Z_{out}$

$R_{if} = R_s + R_i + R_{11}$

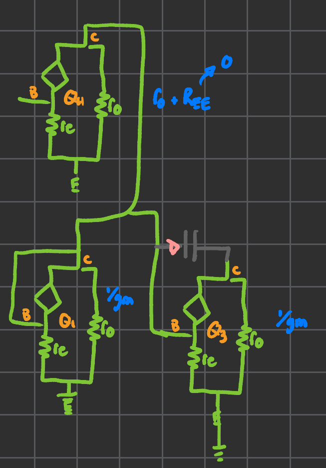


Question 5:

$dB = 20 \cdot \log_{10} \left(\frac{A_{vout}}{A_{vin}} \right)$ $\quad A_v = 1995$

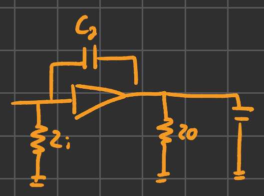
Marge gain $180° - 180° = 5dB$ → on veut 10

Faut monter phase à 30KHz

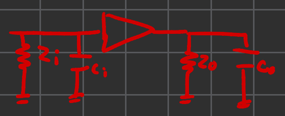


$Z_{out} = r_{eQ_3} // r_{oQ_3} // r_{eQ_3}$

$Z_{out} = \frac{r_e}{2}$



$\Rightarrow$ Miller



$Z_i = 1/g_{mQ_1} \parallel r_{oQ_4}$

$Z_o = Z_{C1} \parallel r_{oQ_3}$

$C_i = C_2(1-A) \approx C_2|A|$

$C_o = C_2(1-1/A) \approx C_2$ $\rightarrow$ negligable

$A = 1995$

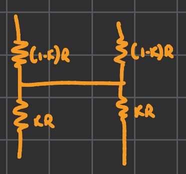
$$R = \frac{r_e}{2} = \frac{0.025}{\frac{0.010}{2}} = \frac{2.5}{2} = 1.25$$

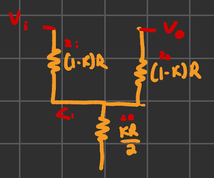
$\Rightarrow C = C_i = C_2|A|$

$$f = \frac{1}{2\pi RC}$$

$$C_2 = \frac{1}{2\pi R|A|f} = \frac{1}{2\pi \cdot 1.25 \cdot 1995 \cdot 30000} = 212 \cdot 10^{-9} = 212\,nF$$

Question 8





$R_{11} = (1-K)R + \frac{KR}{2} \parallel (1-K)R$

$R_{22} = (1-K)R + \frac{KR}{2}$

$$B = \frac{\frac{KR}{2}}{\frac{KR}{2} + (1-K)R}$$

Question 9:

$\boxed{\text{Poles}}$

$$Z_o = 1HK \parallel 100 + \frac{r_\pi + R_{BB}}{(\beta+1)} = r_e$$

$Z_o = 1HK \parallel 100 + r_e$

$Z_o = 1HK \parallel 100 + 25.9$

$Z_o = 125.9$

$$f = \frac{1}{2\pi RC} = \frac{1}{2\pi \cdot 125.9 \cdot 47 \cdot 10^{-6}} = 27\,Hz$$

$\boxed{\text{Zeros}}$

$$A_{BF} = \frac{-g_m R_c}{1 + g_m R_E} = \frac{-39.1 \cdot 10^{-3} \cdot 650}{1 + 39.1 \cdot 10^{-3} \cdot 14100} = -26.7\,dB$$

Basse freq = avec R

$$A_{HF} = \frac{-39.1 \cdot 10^{-3} \cdot 650}{1 + 39.1 \cdot 10^{-3} \cdot 100} = -5.18 = 14\,dB$$

Haute freq ca shot

$14 - -26 = 40dB$

donc deux décades

donc $27Hz/100 = 0.27\,Hz$