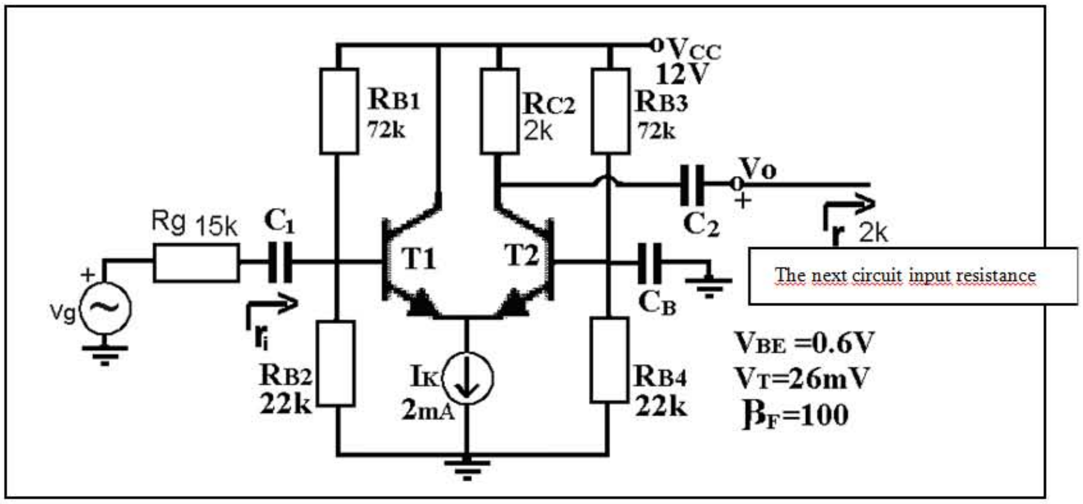
For the transistors in the figure $\beta_F=100$ and $V_{BE}=0.6V$ are given ($V_T=26mV$).

a) find the mid-band gain of the circuit (vo/vg).

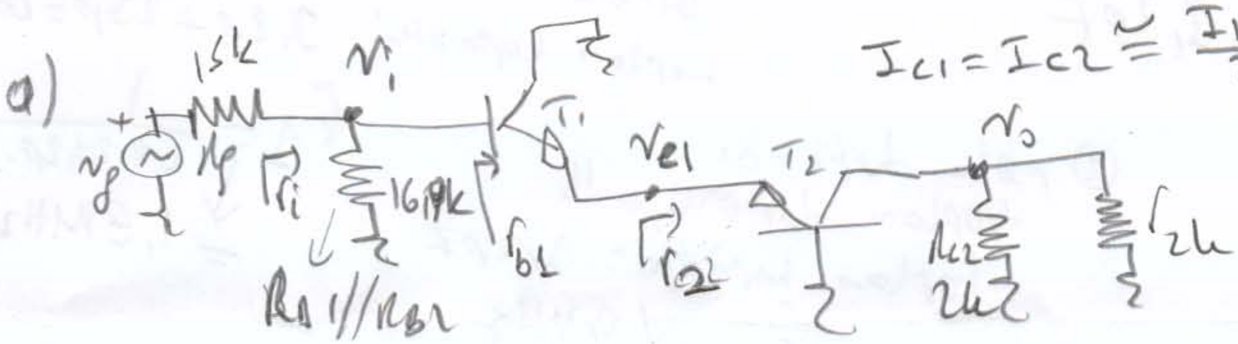
b) Design the current source IK by using the current-mirror structure (show the structure in the circuit).

c) Find the high-frequency region cut-off frequency.

d) In order increase the bandwidth of the circuit without sacrificing the gain, LC-compensation method will be used in the circuit. Show the place of the inductance. Find its value and the new cut-off frequency value.



a)



$I_{C1}=I_{C2}\cong\frac{I_k}{2}=1mA$

$r_{b1}=\beta_F(r_{e1}+r_2)$ $\quad r_2=\frac{1}{g_{m2}}=r_{e2}$

$r_{e1}=r_{e2}=\frac{V_T}{I_C}\cong 26\Omega$

$r_{b1}=100(26+26)=5,2k$ $\quad r_i=R_{B1}//R_{B2}//r_{b1}\cong 4k$

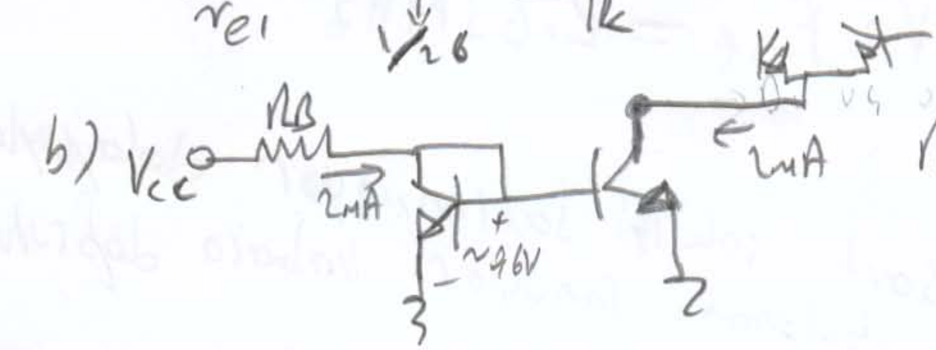
$\frac{v_i}{v_g}=\frac{r_i}{R_g+r_i}=\frac{4}{15+4}=\frac{4}{19}$

$\frac{v_{e1}}{v_i}=\frac{g_{m1}\cdot r_2}{1+g_{m1}\cdot r_2}=\frac{1}{2}$

$\frac{v_o}{v_{e1}}=\underbrace{g_{m2}}_{1/26}\cdot(\underbrace{R_{C2}//r_i}_{1k})=38,5$

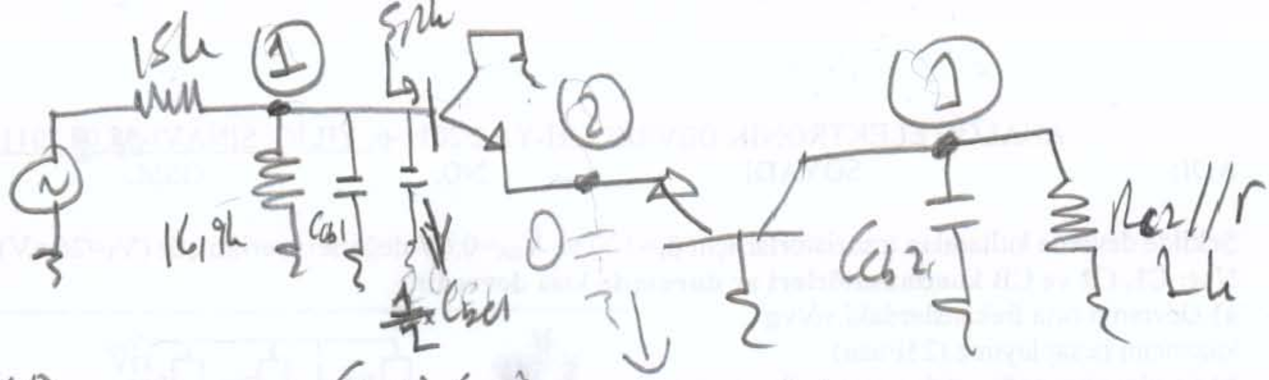
$\frac{v_o}{v_g}\cong 4$

b)



$R_B=\frac{V_{CC}-V_{BE}}{2mA}=\frac{12-0,6}{2mA}\cong 57k\Omega$

c)



$(1-k) \cdot C_{be1}$

$C_{be1}\left(1-\frac{1}{\frac{1}{2}}\right) + C_{be2} = 0$

$C_{be1}\left(1-\frac{1}{k}\right)$

$r_e = 26\Omega$

$f_T = 115\,MHz$

$C_{be} = 50pF$

$C_{cb} = \frac{1}{2\pi r_e f_T} - C_{be}$

$C_{cb} = 3,2pF$

at node-1

total resistance : $15k // 16,9k // 5,2k = 3,1k$

total capasitance : $3,2p + 25p = 28,2p$

$f_1 = \frac{1}{2\pi\, 28,2p \cdot 3,1k} = 1,8\,MHz$

at node-2

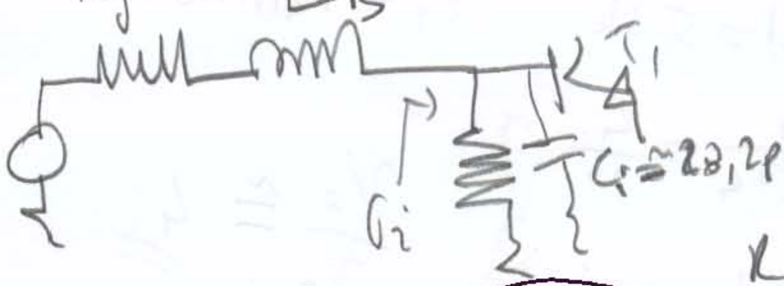
total resistance : $1k$

total capasitance : $3,2pF$

$f_2 = 49\,MHz$

$f_1 << f_2 \qquad f_{ust} = 1,8\,MHz$

d)



$R_B = R_g // r_i$ ($R_g \to 15k$, $r_i \to 4k$)

$= 15k // 4k \cong 3,1k$

$R_A = R_g + r_i = 19k$

$L_B = \frac{R_A R_B^2 \cdot C_i}{2 r_i} = 0,64\,mH$

$f'_{ust} = \sqrt{2}\, f_{ust} = 2,63\,MHz$

!

$C_i R_B >> L R_A$

$87n >> 33n$

?

LB equation condition is not valid powerfully!!!

The approximation may not be enough.
But, the problem can be easily removed
by using simulation programs