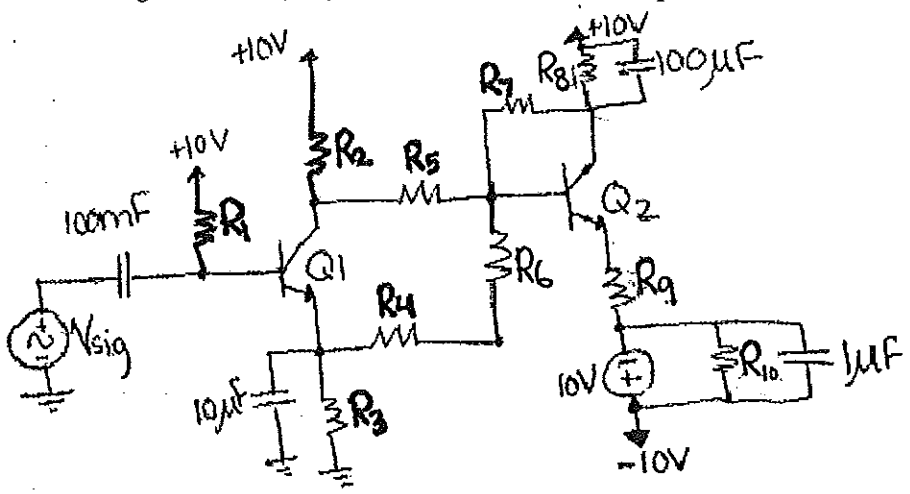
HW

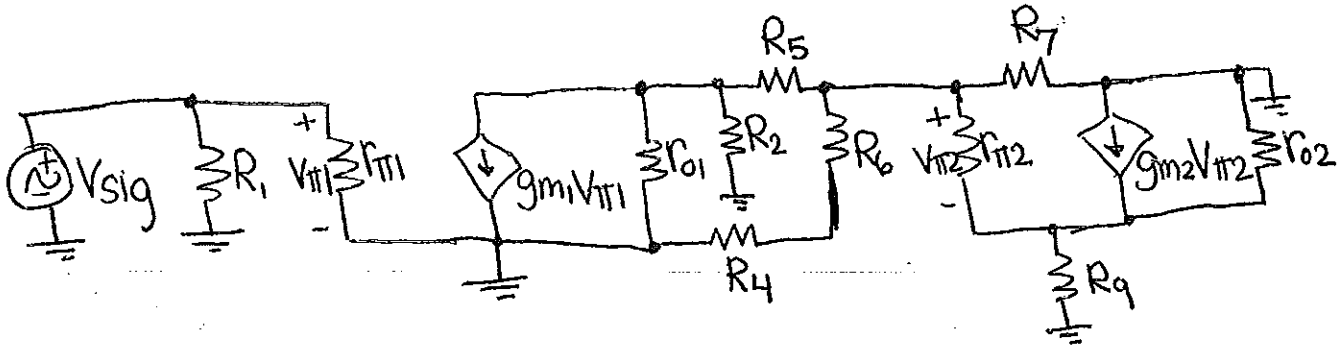
#5. R in emitter should be 4k instead of 40.

#10. Base R is 4Meg

Problem 3 – (15 points)

For the circuit shown below, **draw** the AC small-signal equivalent circuit(use hybrid-π or model T). Make sure that everything is labeled in terms of the transistor number. (e.g. g_{m1}, $v_{\pi 2}$, etc.). **Include r_o** for all transistors. v_{sig}=0.001sin(10t) AC. Assume that the capacitors act as a short.





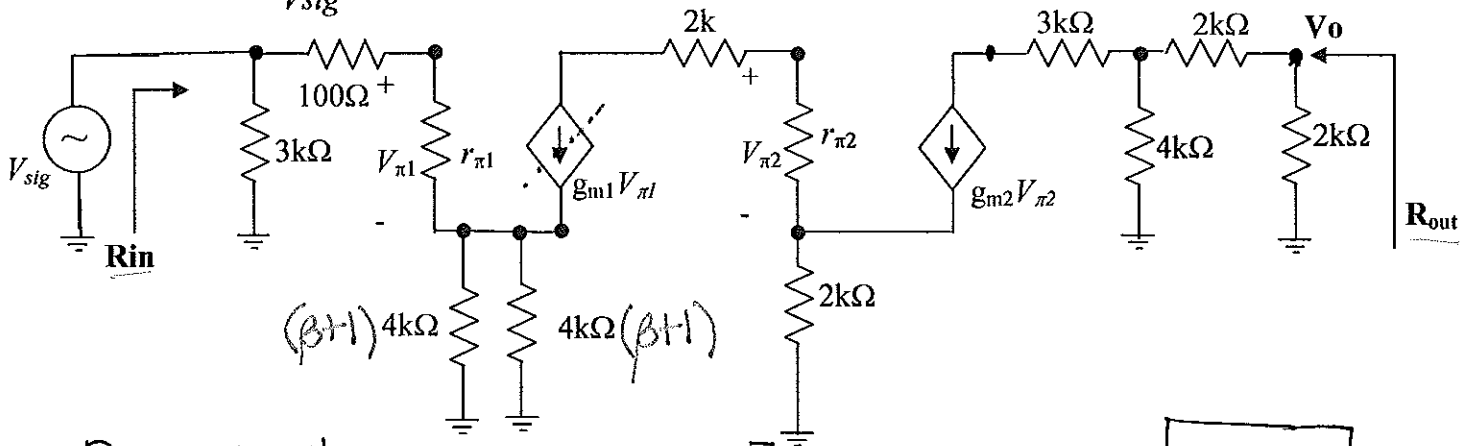
Problem 2

Use: **ignore r_o and r_x, $|V_{BE}|$=0.7, β=100, V_T=25mV**
V_I = 10+0.002sin(20t)

$r_{\pi 1}$=1, 200 g_{m2}=25mA/V, and I_{B2}=6.25μA. Find $r_{\pi 2} = \frac{\beta}{g_m} = \frac{100}{25m} = 4k$ OR $r_{\pi 2} = \frac{V_T}{I_B}$

$r_{\pi 2} = \frac{25m}{6.25\mu}$

For the following hybrid-π equivalent circuit below, find the following values:
(a) R_{in} (input resistance –ignore only the input source, Vsig and include all resistors at the base)
(b) R_{out} (output resistance-include **all** resistors at the collector{no load is connected})
(c) midband gain, $\frac{Vo}{Vsig}$



$R_{in} = 3k \,||\, [100 + r_{\pi 1} + 2k(\beta+1)] = 3k \,||\, 206k = \boxed{2.96k}$

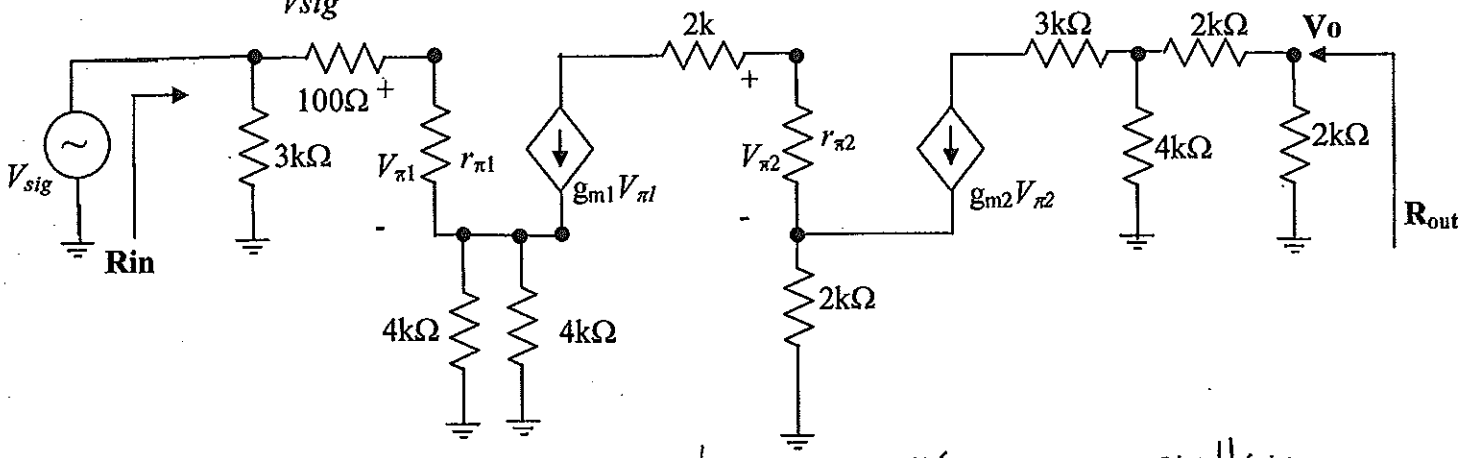
$R_{out} = 2k \,||\, 6k = \boxed{1.5k}$

Problem 2 – (30 points)

Use: **ignore r_o and r_x, $|V_{BE}|=0.7$, $\beta=100$, $V_T=25mV$**
$V_I = 10+0.002\sin(20t)$

$r_{\pi 1}=1$, 200 $g_{m2}=25mA/V$, and $I_{B2}=6.25\mu$; $r_{\pi 2}=\frac{\beta}{g_m}=\frac{100}{25m}=4K$ or $r_{\pi 2}=\frac{V_T}{I_B}=\frac{25m}{6.25\mu}$

For the following hybrid-π equivalent circuit below, find the following values:
(a) R_{in} (input resistance –ignore only the input source, Vsig and include all resistors at the base)
(b) R_{out} (output resistance-include **all** resistors at the collector{no load is connected})
(c) midband gain, $\frac{Vo}{Vsig}$



$R_{in} = 3K \| [100 + r_{\pi 1} + 2K(\beta+1)]$ ($r_{\pi 1} = 4K$)

$R_{in} = 3K \| 206K = \boxed{2.96K\Omega}$

$R_{out} = 2K \| (2K+4K) = 2K \| 6K$

$\boxed{R_{out} = 1.5K\Omega}$

$V_o = \left[\underbrace{\frac{-g_{m2}V_{\pi 2}(4K)}{4K+4K}}_{I}\right] \cdot 2K = -25m \cdot 1K\, V_{\pi 2} = -25V_{\pi 2}$

$V_{\pi 2} = -g_{m1}V_{\pi 1} \cdot r_{\pi 2} = -\underbrace{\frac{\beta}{1,200}}_{83.3m} \cdot V_{\pi 1} \cdot 4K = -333V_{\pi 1}$

$V_{\pi 1} = \frac{Vsig\,(r_{\pi 1})}{100 + r_{\pi 1} + 2K(\beta+1)} = \frac{Vsig\,(1,200)}{203.3K} = 5.9mVsig$

$\frac{V_o}{Vsig} = -25(-333)(5.9m)\,Vsig \cong \boxed{+49 V/V}$