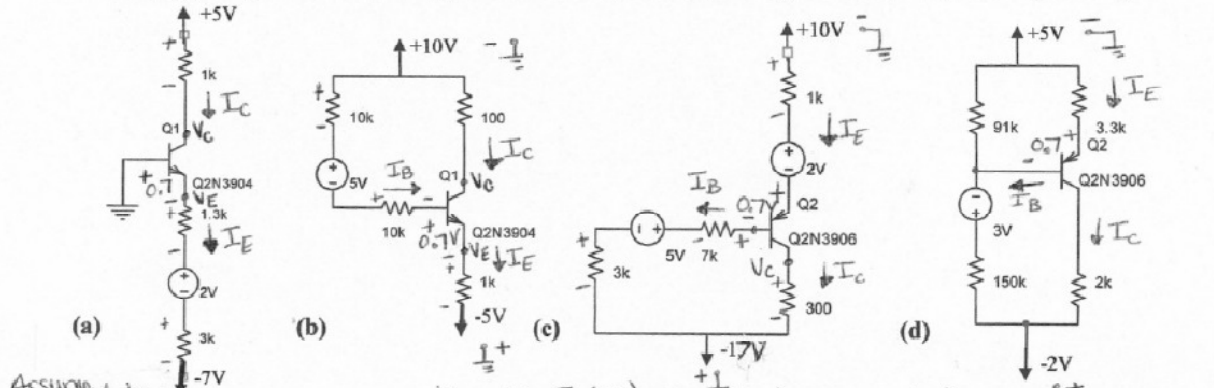
PROBLEM SESSION 6

1. Use $|V_{BE}|=0.7$, $\beta=100$. Find voltages at all nodes and currents through all branches. *(worth 4 problems)*



Assume Active

a. $+0.7 + 1.3k(I_E) + 2 + 3k(I_E) - 7 = 0$

$I_E = \frac{(5-0.7)}{4.3K} = \boxed{1mA}$

$-7 + I_E(3k) + 2 + I_E(1.3k) - V_E = 0$

$V_E = -5 + I_E(4.3k) = \boxed{-0.7V}$

$I_c = \alpha I_E = \frac{100}{101}(1m) = \boxed{0.99m}$

$\boxed{V_B = 0}$

$5 - I_c(1K) - V_c = 0$

$V_c = 5 - I_c(1k) \cong \boxed{+4V}$

$V_c > V_B > V_E \rightarrow$ Active mode ✓

b. $+10 - I_B(10K) - 5 - I_B(10K) - 0.7 - I_E(1K) + 5 = 0$

$I_B = \frac{I_E}{(\beta+1)} \Rightarrow I_E = \frac{9.3}{\left[\frac{20K}{(\beta+1)}\right] + 1K} = \boxed{7.76mA}$

$I_c = \beta \cdot I_B \Rightarrow I_c = \alpha I_E = \boxed{7.69mA}$

$I_c = \alpha I_E$

$I_B = \boxed{76.9\mu A}$

$V_c = 10 - 100(I_c) = \boxed{9.2V}$

$V_B \approx 5 - I_B(20K) = \boxed{3.5V}$

$V_c > V_B > V_E$ Active ✓

$V_E \cong -5 + 1k(I_E) \cong \boxed{2.8V}$

c. $+10 - I_E(1K) - 2 - 0.7 - I_B(7K) - 5 - 3K(I_B) + 17 = 0$

$I_B = I_E/\beta+1 \Rightarrow I_E = \frac{19.3}{\left(\frac{10K}{\beta+1}\right) + 1K} = \boxed{17.6mA}$

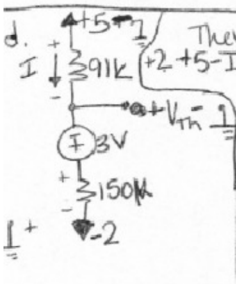
$I_c = \alpha I_E = \boxed{17.4mA}$

$I_B = I_c/\beta \cong \boxed{174\mu}$

$-17 + 3K(I_B) + 5 + 7K(I_B) = V_B \Rightarrow V_B = -12 + 10K(I_B)$

$V_B = \boxed{-10.26V}$; $V_E \Rightarrow +10 - I_E(1K) - 2 - V_E = 0 \Rightarrow V_E = \boxed{-9.6V}$

$-17V + I_c(300) - V_c = 0 \Rightarrow V_c = \boxed{-11.78V}$ $V_c < V_B < V_E$ ✓

d. 

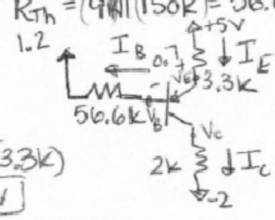
Thevenin $\Rightarrow$

$+2 + 5 - I(91K) + 3 - I(150K) = 0$

$I = \frac{10}{241k} = 41.5\mu$

$+5 - I(91K) - V_{Th} = 0 \Rightarrow V_{Th} \cong 1.2V$

$R_{Th} = (91K || 150K) = 56.6K$



$+5 - I_E(3.3K) - 0.7 - I_B(56.6K) - 1.2 = 0$

$I_B = \frac{I_E}{(\beta+1)} \Rightarrow I_E = \frac{3.1}{3.3K + \left(\frac{56.6K}{\beta+1}\right)} = \frac{3.1}{3.3K + 560} = \boxed{.8m}$

$I_c = \alpha I_E = \frac{100}{101}(.8m) \cong \boxed{.8m}$

$I_B = \frac{I_E}{101} = \boxed{8\mu A}$

$V_E = 5 - I_E(3.3K) = \boxed{2.36V}$

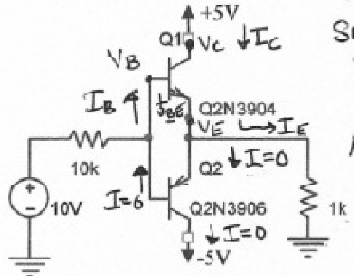
$V_B = V_E - V_{EB} = \boxed{1.66V}$

$V_c = -2 + I_c(2K) = \boxed{-0.4V}$

$V_c < V_B < V_E$ ✓ Active

2. Use $|V_{BE}|$=0.7, β=100. Find voltages at all nodes and the currents through all branches. $V_{CE-SAT} = 0.2V$

Q1 on, Q2 off: they can not both be on at the same time. (See Example 5.12 in the book).
{Can not have current flow "into" the +10V supply}.



Assume active: $+10 - I_B(10K) - 0.7 - I_E(1K) = 0$ $\quad I_B = \frac{I_E}{\beta+1}$

$\Rightarrow I_E = 8.5m$ $\quad \therefore V_E = 8.5V, \; V_B = 9.2V$

$V_C = +5V$

$\therefore V_C < V_B > V_E$!! NOT ACTIVE

Assume SAT: $V_{CE} = 0.2V$

$+5 - V_{CESAT} - \underbrace{I_E(1K)}_{V_E} = 0$

$\therefore V_E = \boxed{4.8V}$

$V_B = 4.8 + 0.7 = \boxed{5.5V}$

$V_C = \boxed{5V}$

$5 < V_B > V_E$ ✓ SAT

For Q2:

$V_{EB} = 4.8 - 5.5 = -0.7 < 0.7$ $\therefore$ off

$I_E = \frac{V_E}{1K} = \boxed{4.8m}$

$I_B = \frac{(10 - 5.5)}{10K} = \boxed{0.45m}$

$I_C = I_E - I_B = \boxed{4.35m}$

3. Assume active operation for all transistors. (Vsin is an ac source)

+10V