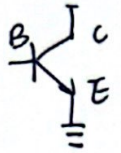
VE311 HW3

Problem 1.



$I_C = \beta I_B \in [500, 3000]\mu A$.

$I_E = I_C + I_B \in [510, 3010]\mu A$.

$P_{max} = U \cdot I_{Cmax} = 30mW$.

Problem 2.

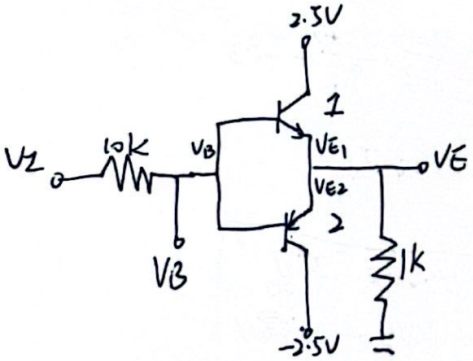
$$R_C = \frac{9 - 0.7}{1mA} = 8300\Omega$$

① Full scale: $\beta = \frac{0.95}{0.05} = 19$

② 1/5: $\beta = \frac{0.99}{0.01} = 99$

③ 1/10: $\beta = \frac{0.995}{0.005} = 199$

Problem 3.



① $V_I = 0V$.

if BJT ① is on.

$\frac{V_E}{1000} = \frac{V_I - V_B}{10000} \cdot 51$

$V_E = V_B - 0.7$.

$\Rightarrow V_B = 0.115 > 0$. X.

if BJT 2 is on:

$\frac{-V_E}{1000} = 51 \cdot \frac{V_B - V_I}{10000}$

$V_E = V_B + 0.7$.

$V_B = -0.115 < 0$ X

So, $V_B = 0$, $V_E = 0$

② $V_I = 2V$.

if BJT 1 is on

$\frac{V_E}{1000} = \frac{V_I - V_B}{10000} \cdot 51$

$V_E = V_B - 0.7$

$V_E = 1.08$

$V_B = 1.78V$ ✓

③ $V_I = -2.5V$.

if BJT 2 is on.

$\frac{V_E}{1000} = 51 \cdot \frac{V_B - V_I}{10000}$

$V_E = V_B + 0.7$. ✓

$V_B = -2.2 < -2.5$.

So $V_B = -2.2V$, $V_E = -1.5V$

④ $V_I = -5V$.

if BJT 1 is on

$\frac{V_E}{1000} = \frac{51}{10000}(V_I - V_B)$

$V_E = V_B - 0.7$

$V_B = -4.06V < -5V$ X

if BJT 2 is on

$-\frac{V_E}{1000} = 51 \cdot \frac{V_B - V_I}{10000}$

$V_E = V_B + 0.7$

$V_B = -4.29V < -2.5V$ X.

$\Rightarrow V_E = 0V$, $V_B = -5V$

Problem 4.

(a) $V_1=0V$
$V_2=3V$
$V_3=0V$
$V_4=3V$
$V_5=3V$

(b)

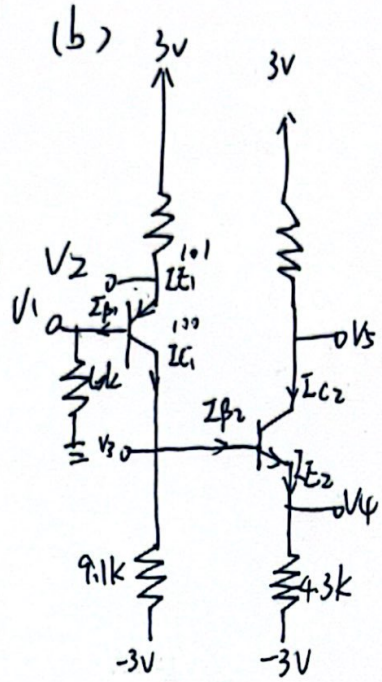
(a) $V_1=0V$.

$V_2=0V+0.7V=0.7V$

$V_3=V_4+0.7V=-0.7V$

$\frac{V_4+3}{4.3}=\frac{3-V_5}{5.1}$

$\Rightarrow$
$V_1=0V$
$V_2=0.7V$
$V_3=-0.7V$
$V_4=-1.4V$
$V_5=1.102V$



$V_2=V_1+0.7$

$\frac{3-V_2}{9.1}=101\cdot\frac{V_1}{10k}=\frac{101}{100}\cdot\frac{V_3+3}{9.1}+I_{B2}$

$\frac{V_4+3}{4.3}=\frac{101}{100}\cdot\frac{3-V_5}{9.1}=100\cdot I_{B2}$

$V_4=V_3-0.7V$

$\Rightarrow$
$V_1=0.0235V$ $V_2=0.7235V$
$V_3=-0.7408V$ $V_4=-1.4408V$
$V_5=1.215V$