Problems:

(a) Find V_1 for the circuit of given figure. Assume h_{FE}= 30 and that silicon transistors are used. (b) Find V_2. (c) Find the value of R_{e1} required to eliminate hysteresis. (d) repeat part c for R_{e2}.

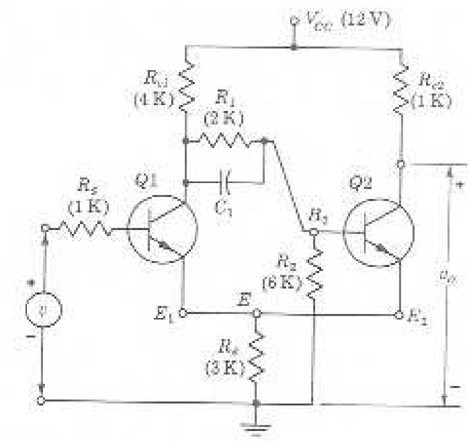
Solution:

(a) From equation(5),

Approximately $V_1 \approx V' - 0.1$

From equation(1), $V' = 6V$

Hence $V_1 = 5.9$ V



For a more accurate calculation,

$$V_1 = V_{EN} + V_{\gamma 1}$$

Where $V_{EN} = (V' - V_{BE2})\dfrac{R_e(1+h_{FE})}{R_b + R_e(1+h_{FE})} = 5.2$ V

So $V_1 = 5.2 + 0.5 = 5.7$V

(b)

we know $V_2 = V_{BE1} + \dfrac{R_e}{aR + R_e}(V' - V_{\gamma 2})$

where $a = \dfrac{R_2}{R_1 + R_2}$, $R = \dfrac{R_{C1}(R_2 + R_1)}{R_{C1} + R_1 + R_2}$

hence $V_2 = 4$ V

(c)

to get zero hysteresis ,either we need to increase V_2 or we need to decrease V_1

the resistor which is connected to the emitter terminal of Q1 will effect the value of V_2. .(since V_2 is calculated by considering Q1 ON & Q2 OFF)

And similarly the resistor which is connected to the emitter terminal of Q2 will effect the value of V_1.(since V_1 is calculated by considering Q1 OFF & Q2 ON)

So here a resistor R_{e1} in series with the emitter of Q1 will effect V_2 but not V_1.

Hence $V_1 = 5.7$ V. from the figure below , with R_{e1} in series with E_1, we see that i_{C1},

Which was determined by the base circuit of Q2 , is uneffected by R_{e1}.

Hence the value of V_{EN2} at which Q2 returns to conduction is the same as before.
However , in order for the currents to remain unchanged with R_{e1} present , $v = V_2$ must be increased by the amount of the voltage drop across R_{e1}.

Hence this resistance must be chosen so that $(i_{C1} + i_{B1})R_{e1}$ is equal to the value of V_H before the addition of R_{e1}.

So $i_{C1} = \dfrac{aV_t - V_{\gamma 2}}{aR + R_e^{'}} = \dfrac{V^{'} - V_{\gamma 2}}{aR + R_e^{'}} = 1.08$ mA

And $i_{B1} = \dfrac{1.08}{30} = 0.04mA$

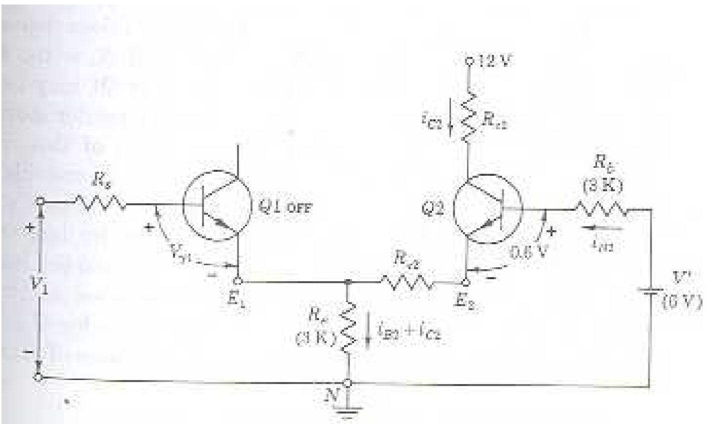
So that hysteresis is eliminated when $V_1 = V_2 + (i_{C1} + i_{B1})R_{e1}$

So $R_{e1} = 1.5K$

(d)

From the above figure , we see that if we place a resistor R_{e2} in series with the emitter of Q2 it can have no effect on V_2 because Q2 is OFF. Hence V_2 remains at 4 V .
However , from the figure below it is clear that R_{e2} will effect V_{EN1} and hence V_1.
From the base circuit of Q2

$$-6 + 3i_{B2} + 0.6 + (R_{e2} + 3)(i_{B2} + i_{C2}) = 0$$



Using $i_{B2} = \frac{i_{C2}}{h_{FE}}$, we obtain $i_{C2} = \frac{5.4}{(1.03R_{e2} + 3.2)}$ and

$V_{EN1} = (i_{C2} + i_{B2})R_e = \frac{16.7}{1.03R_{e2} + 3.2}V$

$V_1 = V_{EN1} + V_{\gamma 1} = V_2 = 4V$ for zero hysteresis. Hence

$1.03R_{e2} + 3.2 = \frac{16.7}{4 - 0.5} = 4.77$

$R_{e2} = 1.5K$