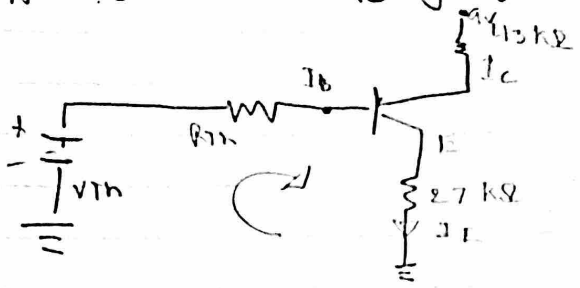
BJT HW 2 Digitron

1 ⇒



$V_{Th} = \left(\frac{36k\Omega}{36k\Omega + 68k\Omega}\right) \times 9V \Rightarrow V_{Th} = 3.115V$

$R_{Th} = (68k\Omega \,//\, 36k\Omega) = \frac{68k\Omega \times 36k\Omega}{68+36} \Rightarrow$

$R_{Th} = 23.538k\Omega$

- $3.115 - I_B R_{Th} - V_{BE} - I_E(27k\Omega) = 0$

$I_E = (\beta + 1) I_B \Rightarrow I_B = \frac{I_E}{\beta + 1}$

$2.415 - (23.538\,k\Omega) I_B - (51)(27k\Omega) I_B = 0$

$\Rightarrow (1400.538\,k\Omega) I_B = 2.415 \Rightarrow I_B = 1.724 \times 10^{-6} A$

$I_C = \beta_F I_B = 86.27\,\mu A$

$I_E = (\beta_F + 1) I_B = 87.941\,\mu A$

$\Rightarrow 9 - (43k\Omega) I_C - V_{CE} - (27k\Omega) I_E = 0$

$V_{CE} = 9 - 3.707 - 2.374 \Rightarrow V_{CE} = 2.918V$

Qpoint $\Rightarrow I_{CQ} = 86.217\,\mu A$, $V_{CE_Q} = 2.918V$

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$I_C = 1mA$

$\frac{12 - V_C}{R_C} = 1mA \Rightarrow 12 - V_C = 1mA(R_C) \Rightarrow 12 - R_C(1mA) = V_C$

$V_{CE} = 5V \quad V_C - V_E = 5V \quad V_E = 3V$

$V_C = 5 + V_E = 5 + 3 = 8V = V_C$

$12 - R_C(1mA) = 8V \Rightarrow \frac{12-8}{1mA} = R_C \Rightarrow R_C = 4K$

$V_E = I_E R_E \quad I_C = 1mA \quad b = 100 \quad \alpha \frac{B}{B+1} = \frac{100}{101}$

$\frac{I_C}{I_E} = \alpha \Rightarrow I_C = \alpha I_E$

$1mA = \frac{100}{101} \cdot I_E \Rightarrow 1mA(1.01) = I_E = 1.01mA$

$V_E = I_E R_E \qquad 3 = (1.01\,mA)(R_E)$

$\frac{3K\Omega}{1.01} = R_E \Rightarrow R_E = 2.97K\Omega$

$V_B = 0.7 + V_E = 3.7V = V_B$

$V_B = \frac{12R_{B2}}{R_{B1}+R_{B2}} \Rightarrow 3.7 = \frac{12 \times R_{B2}}{R_{B1}+R_{B2}} \Rightarrow 3.7R_{B1} = 12R_{B2} = 3.7R_{B1}$

$R_{B1} = \frac{8.3}{3.7} R_{B2} \Rightarrow$ Let $R_{B2} = 10K\Omega$

$R_{B1} = \frac{8.3}{3.7} \times 10K\Omega \Rightarrow R_{B1} = 22.43K\Omega$

3 $V_{EC} = 2V$, $V_{EB} = 1V$

$V_E - V_C = 2$

$V_E - 2 = V_C \quad V_C = -1V$

$V_{CC} - I_C R_C = V_E \qquad 5 - \frac{I_C}{\alpha} R_E = V_E \qquad I_C = 850\mu A$

$\alpha = \frac{\beta}{\beta+1} \quad \frac{60}{61} \qquad I_C = \frac{I_C}{\alpha} = 864\mu A = I_C$

$5 - (864\mu A) R_E = 1 \Rightarrow R_E = \frac{5-1}{864\mu A} \Rightarrow R_E = 4.629 K\Omega$

$V_C = -1V \Rightarrow \frac{V_C - (-V_{CC})}{R_C} = I_C \Rightarrow \frac{-1+5}{I_C} = R_C \Rightarrow R_C = 4.70 K\Omega$

$V_B = \frac{V_{CC} \cdot R_{B2}}{R_{B1} + R_{B2}} \Rightarrow 0.3(R_{B1}) + 0.3(R_{B2}) = 5 R_{B2}$

$0.3(R_{B1}) = 4.7 R_{B2}$

$R_{B1} = \frac{4.7}{0.3} R_{B2} = \frac{47}{3} R_{B2}$

Let $R_{B2} = 10 K\Omega$

$R_{B1} = \frac{470}{3} K \Rightarrow R_{B1} = 156.66 K\Omega$

5 $C_{diff} = \frac{dQ}{dV} = \frac{d\,I}{dV}\,(t$

$= \frac{5mA}{10V} \times 0.2\times10^{-12}S$

$C_{diff} = 10^{-16}F$

$g_m = \frac{I_C}{V_T} \Rightarrow \frac{5mA}{26mV} = 1.923\times10^{-1}\ \Omega^{-1}$

$f_B = \frac{f_T}{f_{BF}} \quad \frac{1}{2\pi t_f} = \frac{1}{2\pi \times 0.2ps} = 79.5774\times10^{10}$

$f_B = \frac{f_T}{\beta_F} = \frac{79.5774\times10^{10}}{300} = 2.6525\times10^{9}\ Hz$

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