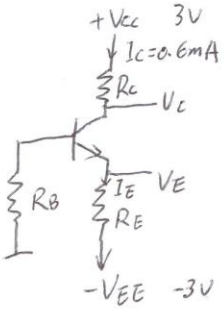
HW 8 EE 20243

6.133



(a) $\beta = \infty$

$I_B = 0,\ V_B = 0,\ V_E = -0.7V$

$V_C = \frac{V_{CC} + V_E}{2} = \frac{3V - 0.7V}{2} = 1.15V$

$R_C = \frac{3V - 1.15V}{0.6mA} = 3.08K\Omega$

$R_E = \frac{3V - 0.7V}{0.6mA} = 3.83K\Omega$

(b) $\beta = 90$ $\quad V_B = \frac{3V - 0.7V}{10} = 0.23V$

$I_B = I_C / \beta = 0.6mA / 90 = 0.00667mA$

$R_B = \frac{V_B}{I_B} = \frac{0.23V}{0.00667mA} = 34.48K\Omega$

(c) Selected R's : $R_C = 3.0K\Omega$ $\quad R_E = 3.6\ K\Omega$, $\quad R_B = 33\ K\Omega$

(d) for $\beta = \infty$: $I_B = 0$, $\quad V_B = 0$, $\quad V_E = -0.7V$

$V_C = V_{CC} - I_C R_C = 3V - \frac{3V - 0.7V}{3.6K\Omega} \times 3K\Omega = 1.08V$

$I_C = (3V - 0.7V) / 3.6K\Omega = 0.64mA$.

For $\beta = 90$: $\quad I_E = \frac{3V - 0.7V}{3.6K\Omega + 33K\Omega / 91} = 0.58mA$

$I_C = I_E \cdot \frac{\beta}{\beta + 1} = 0.58 \times \frac{90}{91} = 0.57mA$

$V_E = -V_{EE} + I_E R_E = -3V + 0.58mA \times 3.6K\Omega = -0.91V$

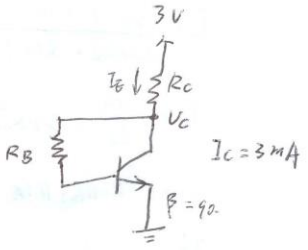
$V_B = V_E + 0.7V = -0.21V$

$V_C = V_{CC} - I_C R_C = 3V - 0.57mA \times 3.0K\Omega = 1.29V$

6.136 (a) $V_C = \frac{V_{CC}}{2} = 1.5V$ $\quad \beta = 90$

$I_E = \frac{3V - 1.5V}{R_C} = \frac{1.5V}{R_C} = \frac{I_C}{\alpha} \Rightarrow R_C = 494.5\Omega$

$R_B = \frac{1.5V - 0.7V}{I_C / \beta} = \frac{0.8V}{3mA/90} = 24K\Omega$



(b) selected R's

$R_B = 24K\Omega \quad R_C = 495\Omega \rightarrow 510\Omega$

then $I_E = \dfrac{3V-0.7V}{510\Omega + \frac{24K\Omega}{91}} = 2.97mA$

$I_C = \alpha I_E = 2.94mA$

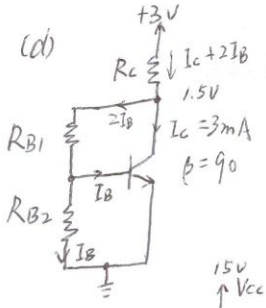
$V_C = 3V - 2.97mA \times 510 = 1.485V$

(c) $\beta = \infty,\ I_B = 0,\ V_B = 0.7V$

$I_C = I_E = \dfrac{3V-0.7V}{510\Omega} = 4.5mA$

$V_C = 3V - 4.5mA \times 510\Omega = 0.705V$

(d)



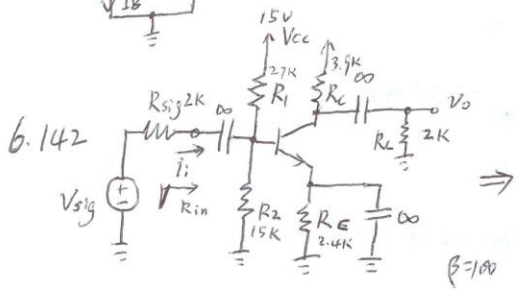
$I_B = \dfrac{I_C}{\beta} = \dfrac{3mA}{90} = 0.033mA$

$1.5V - 0.7V = 2I_B \times R_{B1} \Rightarrow R_{B1} = \dfrac{0.8V}{2 \times 0.033mA} = 12.12K\Omega$

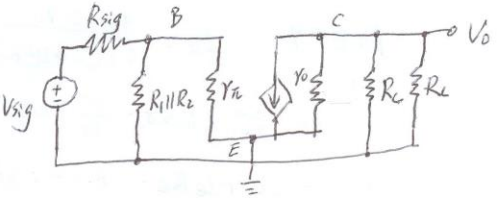
$0.7V = I_B \times R_{B2} \Rightarrow R_{B2} = \dfrac{0.7V}{0.033mA} = 21.21K\Omega$

$(I_C + 2I_B)R_C = 3V - 1.5V \Rightarrow R_C = \dfrac{1.5V}{3mA + 2 \times 0.033mA} = 489\Omega$

6.142



$\Rightarrow$



$\beta = 100$

$V_{BB} = 15V \cdot \dfrac{R_2}{R_1+R_2} = 15V \cdot \dfrac{15}{15+27} = 5.36V, \quad R_1 \| R_2 = 9.64K\Omega$

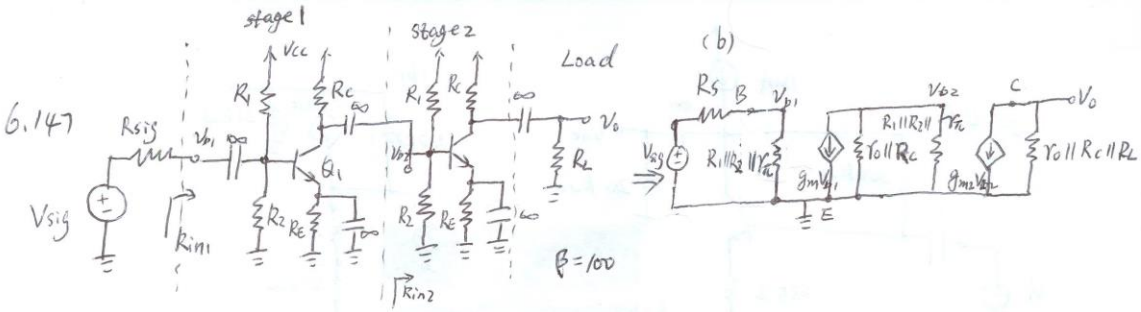
$I_E = \dfrac{5.36V - 0.7V}{2.4K\Omega + 9.64K\Omega/101} = 1.87mA, \quad g_m = \dfrac{I_C}{V_T} = \dfrac{1.87mA \times \frac{100}{101}}{0.025V} = 74A/V$

$r_o = \dfrac{V_A}{I_C} = 54K\Omega, \quad r_\pi = \dfrac{\beta}{g_m} = 1.35K\Omega,$

$R_{in} = R_1 \| R_2 \| r_\pi = 1.18K\Omega$

$\dfrac{V_o}{V_{sig}} = -\dfrac{R_{in}}{R_{in}+R_{sig}} g_m (r_o \| R_C \| R_L) = -\dfrac{1.18}{3.18} \times 74 \times 1.29 = -35.4V/V$

6.147



(a) $V_{BB} = V_{cc}\frac{R_2}{R_1+R_2} = 9V \times \frac{47}{47+100} = 2.88V$, $R_1 \| R_2 = 31.97K\Omega$

$$I_E = \frac{(2.88-0.7)V}{3.9k\Omega + 31.97k\Omega/101} = 0.517mA \text{ , } I_C = \frac{100}{101}\times 0.517mA = 0.512mA$$

$$V_C = V_{cc} - I_C R_C = 9V - 0.512mA \times 6.8k\Omega = 5.52V$$

(b) $g_m = \frac{I_C}{V_T} = \frac{0.512mA}{25mV} = 0.020A/V$, $r_\pi = \frac{\beta}{g_m} = \frac{100}{0.020} = 5K\Omega$

$$r_o = \frac{V_A}{I_C} = 195.3K\Omega$$

(c) $R_{sig} = 5k\Omega$

$$R_{in1} = R_1 \| R_2 \| r_\pi = 4.32\,K\Omega$$

$$\frac{V_{b1}}{V_{sig}} = \frac{R_{in1}}{R_{in1}+R_{sig}} = \frac{4.32}{9.32} = 0.464$$

(d) $R_{in2} = R_1 \| R_2 \| r_\pi = 4.32k\Omega$ $\quad R_C \ll r_o$

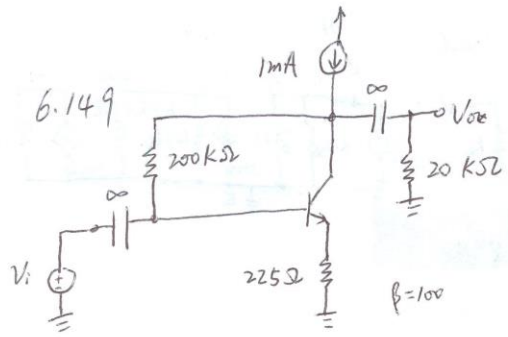
$$\frac{V_{b2}}{V_{b1}} \approx -g_m(r_o \| R_C \| R_{in2}) = 0.020A/V\,(6.57k\Omega \| 4.32k\Omega) = 52.13\,V/V$$

(e) $R_L = 2k\Omega$

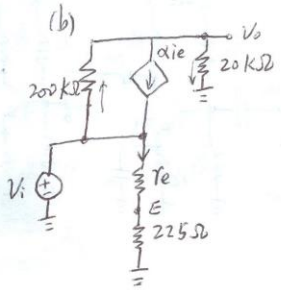
$$\frac{V_o}{V_{b2}} = -g_m(r_o \| R_C \| R_L) = 0.020A/V \times (6.57k\Omega \| 2k\Omega) = 30.67\,V/V$$

(f) $$\frac{V_o}{V_{sig}} = \frac{V_o}{V_{b2}} \cdot \frac{V_{b2}}{V_{b1}} \cdot \frac{V_{b1}}{V_{sig}} = 741.86$$

6.149



(b)



(a) $I_C = \alpha I_E = \frac{100}{101} \times 1mA = 0.99mA$

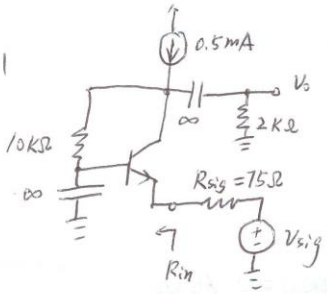
$V_C = I_E R_E + 0.7V + I_B R_B = 1mA \times 225\Omega + 0.7V + 0.01mA \times 200k\Omega = 2.93V$

(b) $r_e = \frac{V_T}{I_E} = 25\Omega$, $ie = \frac{V_B}{r_e + R_E} = \frac{V_i}{250\Omega}$

$$\frac{V_o - V_i}{R_B} + \frac{V_o}{R_L} = -\alpha ie = -\frac{\alpha V_i}{250\Omega}$$

$$\Rightarrow \frac{V_o}{V_i} = \frac{\left(\frac{1}{R_B} - \frac{\alpha}{250}\right)}{\left(\frac{1}{R_B} + \frac{1}{R_L}\right)} = -71.92\ V/V$$

6.151



$\beta = 100$

$I_C = \frac{100}{101} I_E = \frac{100}{101} \times 0.5mA = 0.495mA$,

$r_o = 202k\Omega$, could be ignored

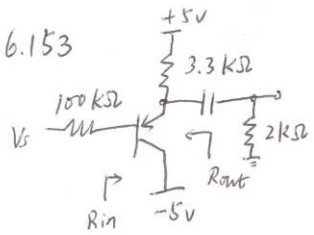
$$R_{in} = r_e = \frac{V_T}{I_E} = \frac{25mV}{0.5mA} = 50\Omega,$$

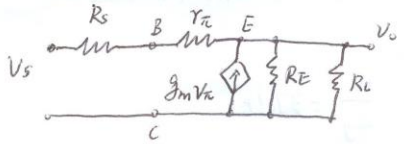
$$\frac{V_o}{V_s} = \frac{r_e}{R_s + r_e} \cdot g_m (R_B \| R_L) \| r_o$$

$$= \frac{50}{75+50} \cdot \frac{0.495mA}{25mV} \times (10k\Omega \| 2k\Omega) \| 202k\Omega)$$

$$= 13.1\ V/V$$

6.153





$$I_E = \frac{(5-0.7)V}{3.3K\Omega + 100K\Omega/101} = 1mA, \quad I_C = 0.99mA. \quad g_m = \frac{I_C}{V_T} = 0.0396\ A/V$$

$$r_e = \frac{V_T}{I_E} = 25\Omega, \quad r_\pi = \frac{\beta}{g_m} = 2.525K\Omega, \quad r_o = 101K\Omega$$

$$R_{in} = (\beta+1)\,[r_e + (R_E \| R_L)] = 101\,(0.025 + 1.25) = 128\ k\Omega$$

$$\frac{V_o}{V_s} = \frac{128}{128+100} \cdot \frac{1.25}{1.25+0.025} = 0.55\ V/V$$

$$\frac{i_o}{i_b} = \frac{V_o/R_L}{V_s/(R_s+R_{in})} = \frac{V_o}{V_s} \cdot \frac{R_s+R_{in}}{R_L} = 63.8\ A/A$$

$$R_{out} = 3.3 \| [r_e + 100/(\beta+1)] = 0.78K\Omega$$