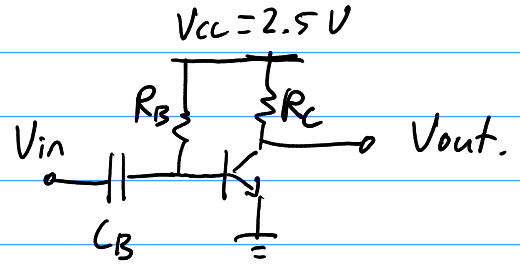
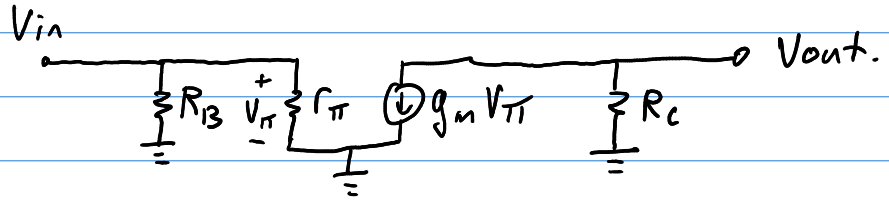
5.74 Given $\beta = 100$, $I_S = 6 \times 10^{-16}$ A, $V_A = \infty$

Design a common emitter for $|A_v| = 10$, $R_{in} > 5\ k\Omega$, $R_{out} = 1\ k\Omega$.



Draw the small signal model



Notice $R_{out} = R_C$ $\therefore$ $R_C = 1\ k\Omega$.

Now find the required bias point.

$|A_v| = g_m R_C = 1000 g_m = 10$.

$\therefore g_m = 10\ mS$.

$I_C = g_m V_T = 10 \times 10^{-3} \times 26 \times 10^{-3}$

$= 260\ \mu A$.

$\therefore I_B = \frac{I_C}{\beta} = 2.6\ \mu A$.

Using KVL from V_{CC} through R_B to ground:

$$V_{CC} = I_B R_B + V_{BE} \quad (1)$$

Also, $V_{BE} = V_T \ln\left(\frac{I_C}{I_S}\right) = 0.026 \times \ln\left(\frac{260 \times 10^{-6}}{6 \times 10^{-16}}\right)$

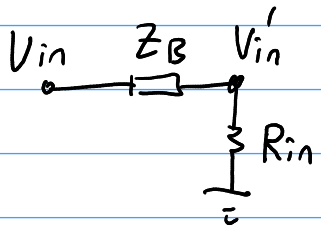
$= 696.7\ mV$.

$\therefore$ From (1), $2.5 = 2.6 \times 10^{-6} \times R_B + 0.6967$

$R_B = 694\ k\Omega$.

Check $R_{in} = R_B \| r_\pi = R_B \| \left(\frac{\beta}{g_m}\right) = 9.86\ k\Omega > 5k\Omega$ ✓

To size C_B, notice that it forms an AC voltage divider with R_{in}.



A plausible design choice is for $|Z_B| = 0.1\ R_{in}$.

$$\therefore \quad \frac{1}{\omega C_B} = 0.1\ R_{in}$$

$$\omega = 2\pi \times 200 = 400\pi$$

$$\therefore \quad \frac{1}{400\pi\, C_B} = 0.1 \times 9.86 \times 10^3$$

$$C_{B(min)} \simeq 800\ nF.$$