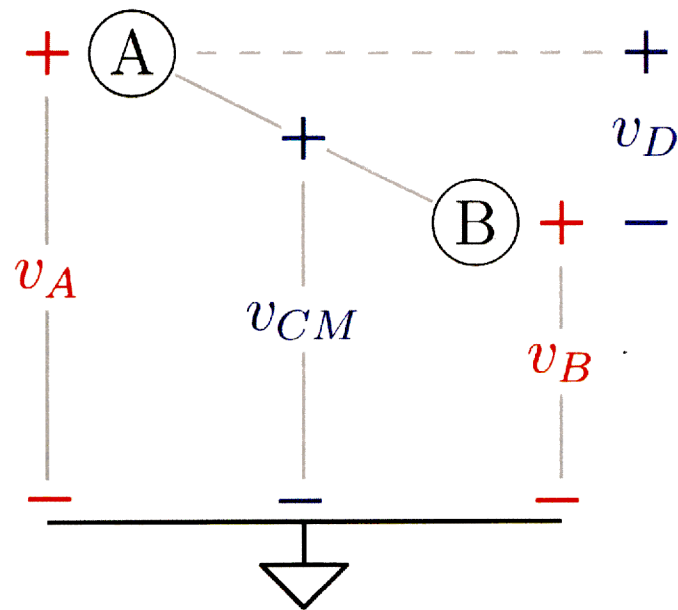
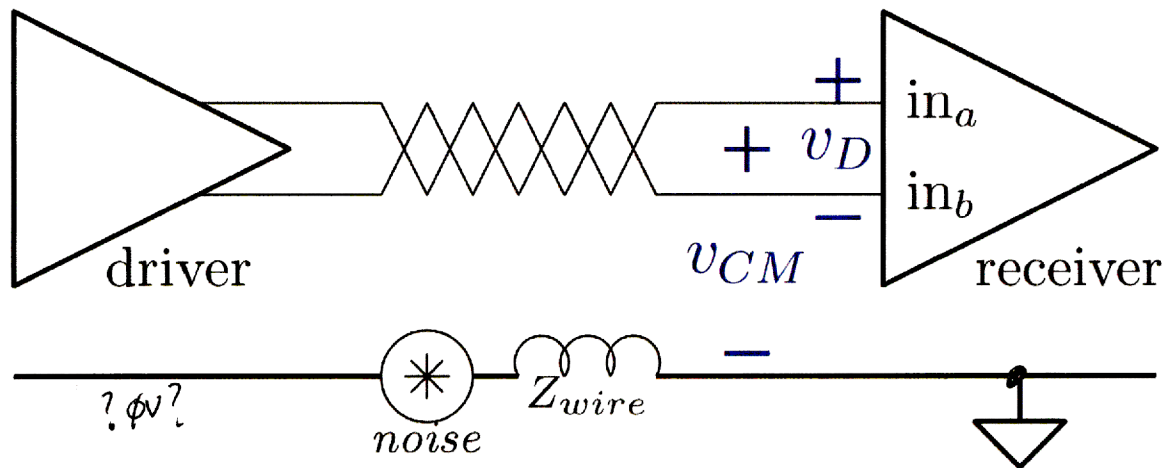


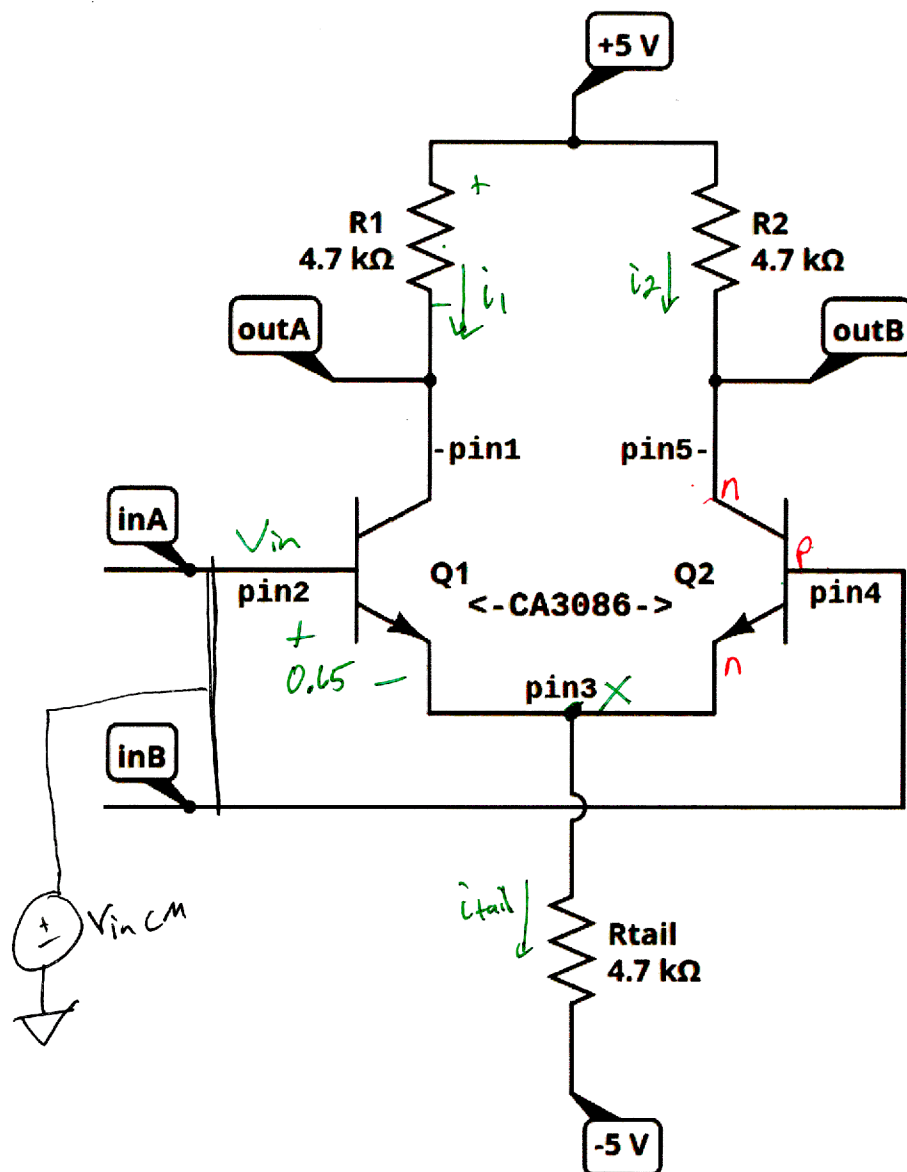
Terminology and definition review: **differential-mode** and **common-mode**



$$\begin{cases} v_D = v_A - v_B \\ v_{CM} = \frac{v_A + v_B}{2} \end{cases}$$

$$\begin{cases} v_A = v_{CM} + \frac{v_D}{2} \\ v_B = v_{CM} - \frac{v_D}{2} \end{cases}$$

From Lab 4



- Tie (short) **inA** and **inB** together
- Find (DC) **VoutA** and **VoutB**
- Range of **Vin(CM)** where Q1 and Q2 are in active mode? find

$$V_x = V_{in} - 0.65V$$

$$i_{tail} = \frac{V_x - (-5)}{4.7k} = \frac{V_x + 5}{4.7k}$$

$$i_1 + i_2 \approx i_{tail} \rightarrow \text{assuming } i_B \rightarrow \phi \quad (\beta \rightarrow \infty)$$

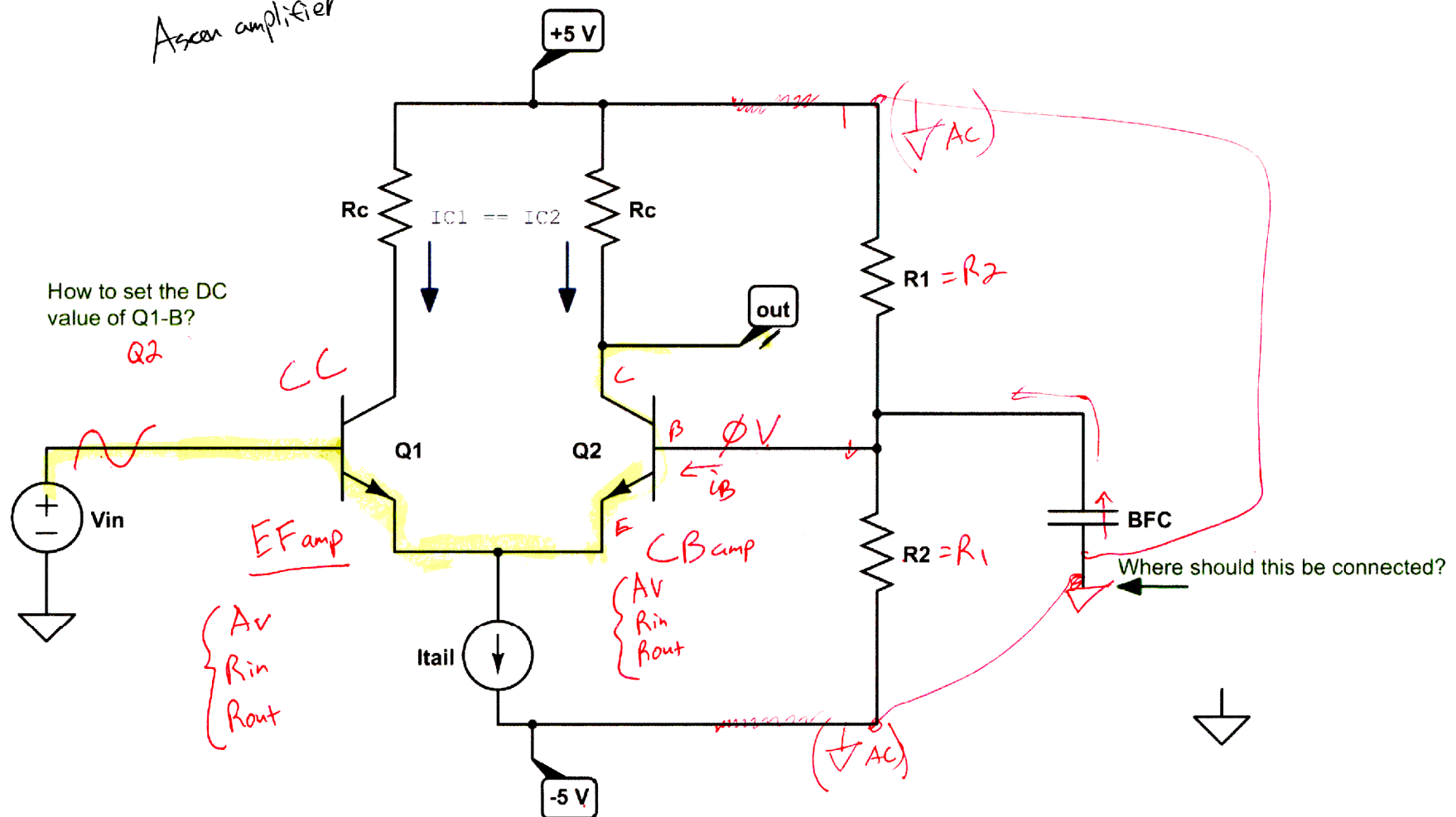
$$\begin{aligned} V_{outA} &= 5 - i_1 \cdot R_1 \\ &= 5 - \frac{(V_{in} - 0.65 + 5) R_1}{4.7k} \end{aligned}$$

$$V_{outB} = 5 - \frac{(V_{in} - 0.65 + 5) R_2}{R_{tail}}$$

$$\begin{aligned} V_C &\geq V_B \quad (\text{npn}) \quad \text{fwd-bias the B-C pn junction} \\ V_{outA} &\geq V_{inCM} \\ V_B &\end{aligned}$$

$$\left\{ \begin{aligned} V_{outA} &\geq 5 - \frac{(V_{in} - 0.65 + 5) R_1}{R_{tail}} \\ &\quad \text{find } V_{in} \\ V_{in} &\geq 0.65V \end{aligned} \right.$$

Asken amplifier



TYPICAL STATIC CHARACTERISTICS

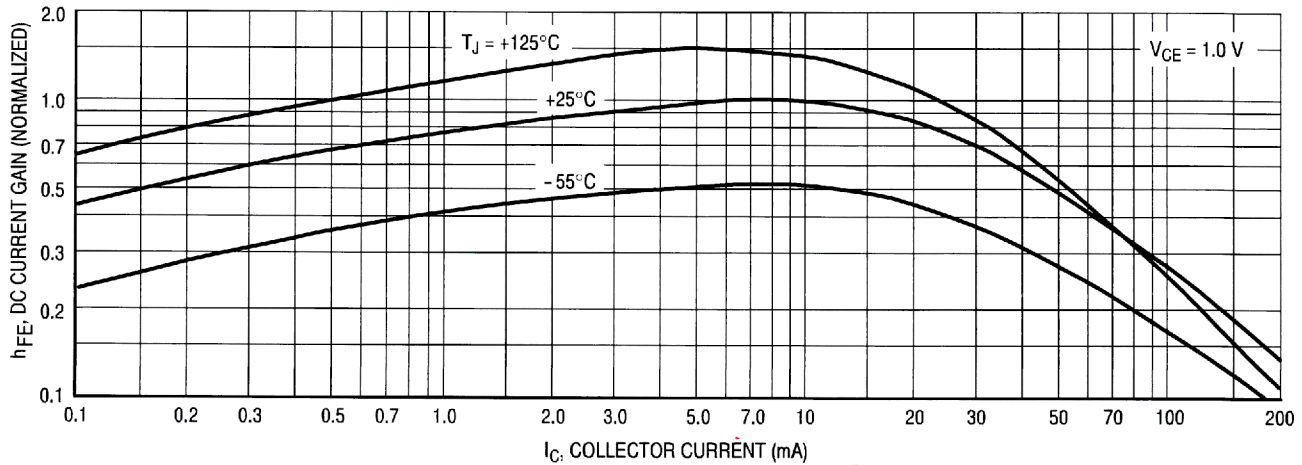
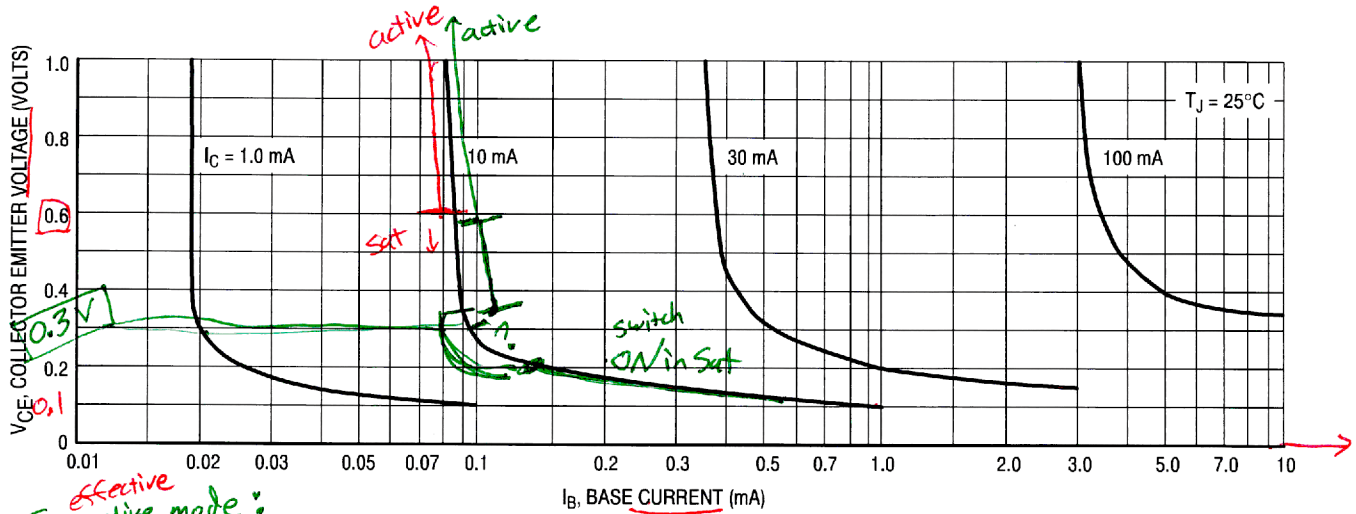
Figure 15. DC Current Gain β 

Figure 16. Collector Saturation Region

In *effective* active mode:
(npn) $V_{CE} > 0.3$

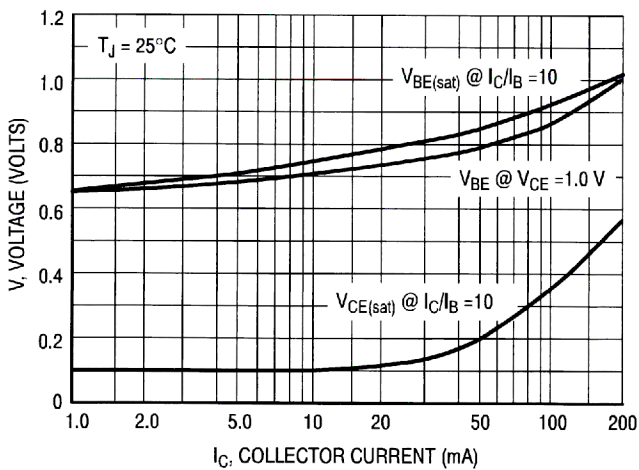


Figure 17. "ON" Voltages

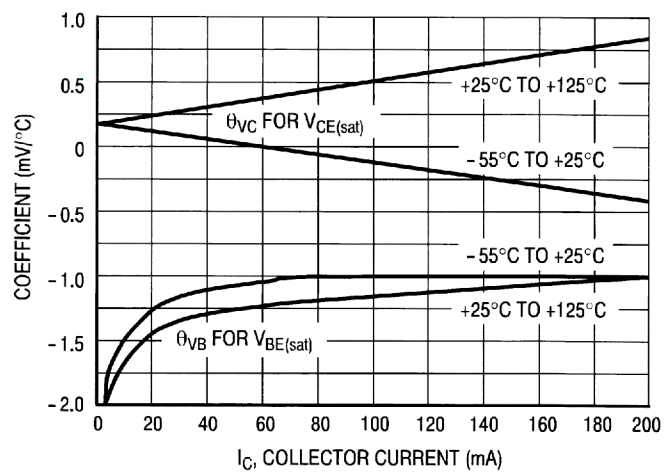


Figure 18. Temperature Coefficients