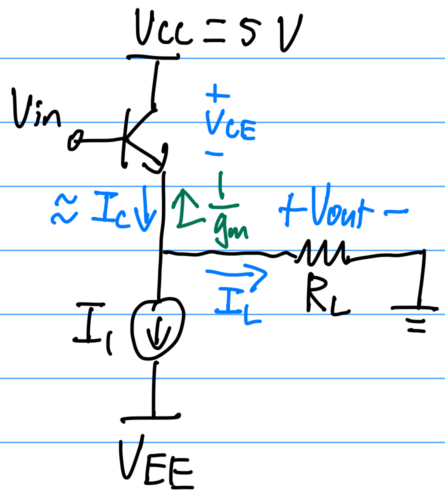


(a) $A_V = \dfrac{R_L}{R_L + \frac{1}{g_m}}$.

$$R_L + \frac{1}{g_m} = \frac{R_L}{A_V}$$

$$\frac{1}{g_m} = \left(\frac{1}{A_V} - 1\right) R_L$$

$$= \left(\frac{1}{0.9} - 1\right) 8$$

$$= 0.889\ \Omega$$

$$g_m = 1.125\ S.$$

$\therefore\ I_C = g_m V_T = 1.125 \times 0.026 = 29.25\ mA.$

(b) By KCL, $I_L = I_C - I_1$

By KVL, $V_{CC} = V_{CE} + V_{out}$

$= V_{CE} + (I_C - I_1) R_L$

$\therefore\ I_C = I_1 + \dfrac{V_{CC}}{R_L} - \dfrac{V_{CE}}{R_L}$.

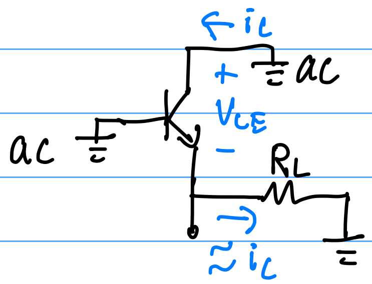
The Q point is when $V_{out} = 0$.

$\therefore\ I_{LQ} = 0 \quad \therefore\ I_{CQ} = I_1$.

$\therefore$ At the Q point: $I_1 = I_1 + \dfrac{V_{CC}}{R_L} - \dfrac{V_{CEQ}}{R_L}$

$\therefore\ V_{CEQ} = V_{CC}$.

(c) The AC model (with independent sources off) is:



Assume $i_C = i_e$.

By KVL, $0 = v_{CE} + i_C R_L$.

Subst. $v_{CE} = \Delta V_{CE} = V_{CE} - V_{CEQ}$

$i_C = \Delta I_C = I_C - I_{CQ}$

$$\therefore\ 0 = V_{CE} - V_{CEQ} + (I_C - I_{CQ}) R_L$$

Subst $V_{CEQ} = V_{CC}$ & $I_{CQ} = I_1$

$$0 = V_{CE} - V_{CC} + (I_C - I_1) R_L$$

$$I_C = I_1 + \frac{V_{CC}}{R_L} - \frac{V_{CE}}{R_L}.$$

(d) Find the axis intercepts. Set $I_C = 0$ first.

$$0 = I_1 + \frac{V_{CC}}{R_L} - \frac{V_{CE}}{R_L}$$

$$V_{CE(max)} = V_{CC} + R_L I_1$$

$$= 5 + 8 \times 29.25 \times 10^{-3}$$

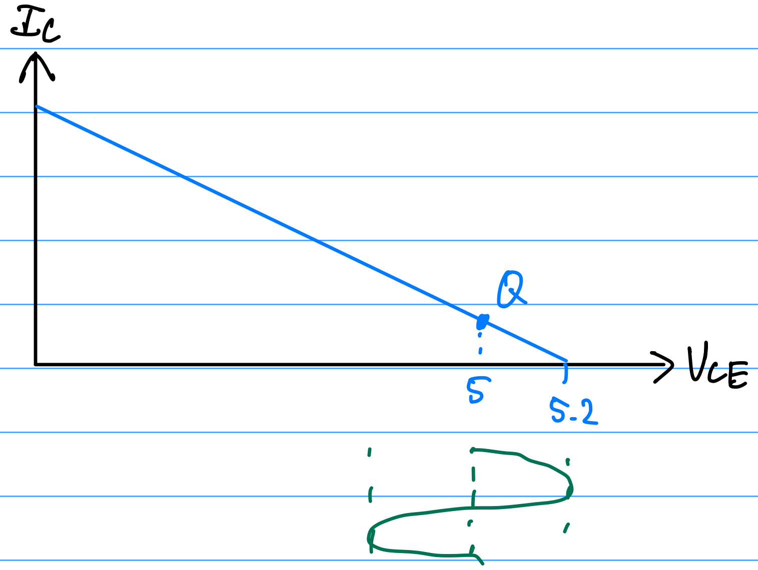
$$= 5.23\ V.$$

Next set $V_{CE} = 0$.

$$I_{C(max)} = I_1 + \frac{V_{CC}}{R_L}$$

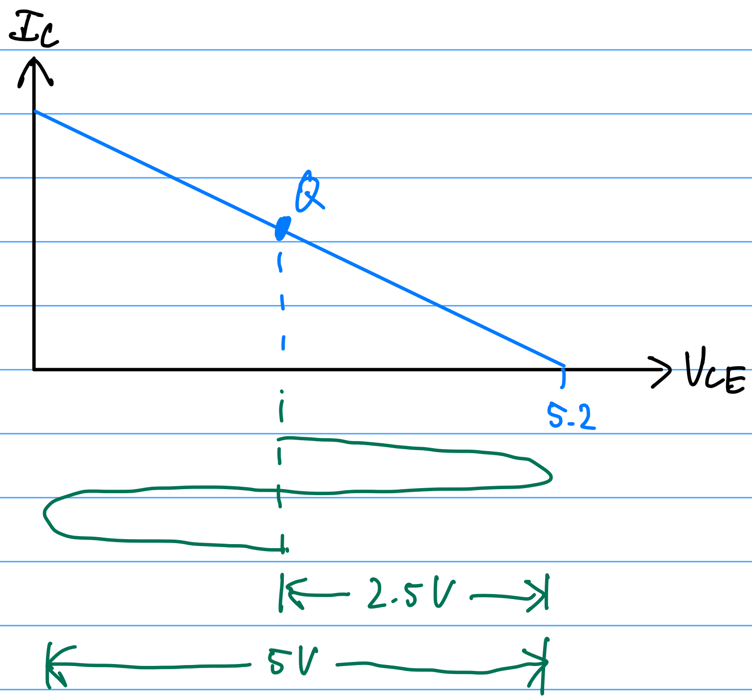
$$29.25 \times 10^{-3} + \frac{5}{8}$$

$$= 0.65\ A$$



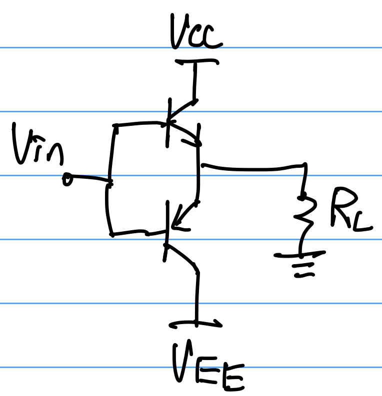
Peak swing = 0.2 V. Peak to peak = 0.4 V.

(e) You may be tempted to move the Q point:



However, this would mean that V_{out} is no longer centered on 0 V.

Notice that this circuit has great headroom in one direction only. We can push current into R_L but can't pull it from R_L. We need another transistor. Actually I_1 is a transistor anyway, so let's make it more useful.



This is a push-pull stage (class B). Hopefully you see the reasoning that leads to this design.