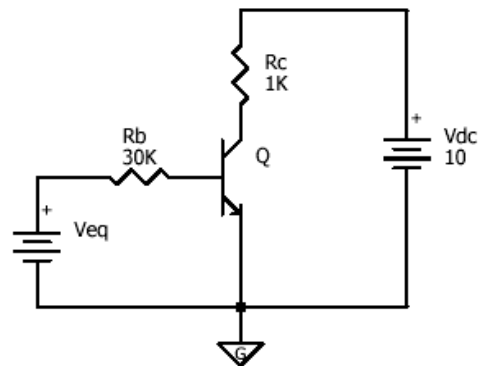


Physics 517/617 Experiment 4A

Basic Experiment - Physics 517/617

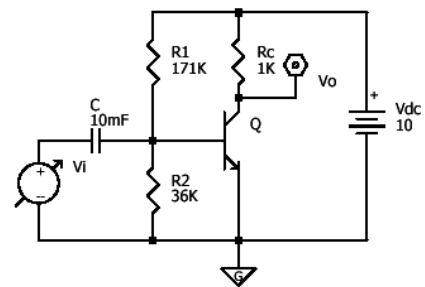
- 1) Build the following circuit to measure the transistors properties. For V_{eq} apply a D.C. voltage which varies from 0.0 to 6V.

- Analyse the data to obtain I_c and I_b .
- Plot and explain the results.
- What is the β or h_{fe} for the transistor?



- 2) Build the following Common-Emitter amplifier. You will have to choose resistors R_1 and R_2 to properly bias the circuit ($V_{CE}=5V$, see appendix). Measure the following properties of your amplifier and compare them to what you expect theoretically with a sinusoidal input, V_i :

- operating point (V_{ce} , V_{be})
- gain (V_o/V_i) frequency response and dependence
- response to large signals



- 3) Using a small signal model with $h_{oe}=0$ we showed in class that the voltage gain of a common-emitter amplifier is equal to:

$$A_V = \frac{h_{fe} R_c}{h_{ie}}$$

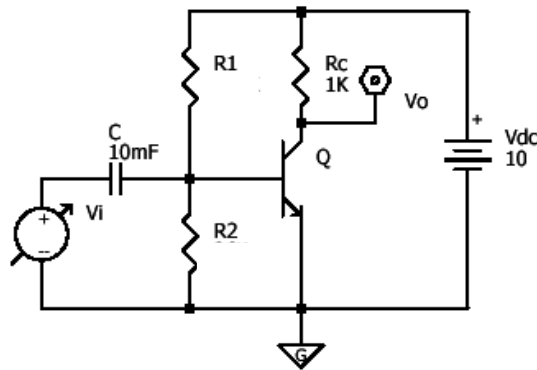
Measure the AC input resistance at 5000 Hz using a resistance divider to obtain h_{ie} .
How well does this small signal model theory agree with your measurements in part 2.

No additional work is required for Physics 617

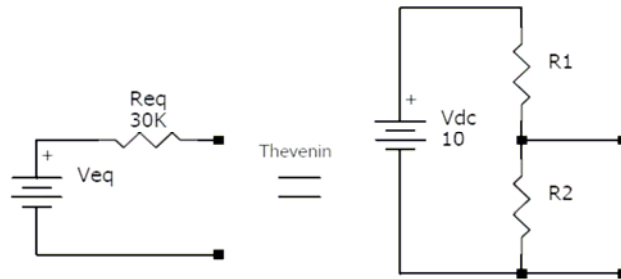
Appendix:

Biasing the CE Amplifier

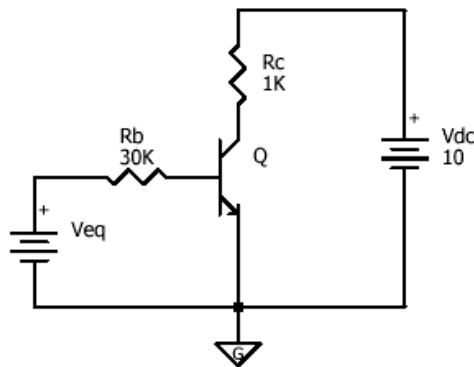
You wish to bias transistor Q in the following circuit.



Thevenin's Theorem can reduce this circuit we used in part 1 of the lab.



We then are left with:



We want to find V_{eq} such that $V_{ce}=5V$. You can do this experimentally by using your data from part 1 (best) or solve numerically(last resort). The two techniques should yield close to the same

V_{eq} . Solving numerically, one applies KVL around our two loop, and require Q to be in the active region.

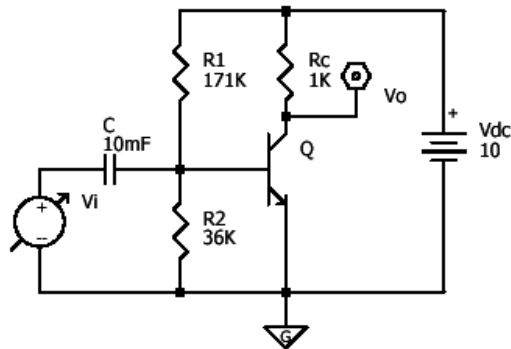
$$\begin{aligned} \text{KVL: } & V_{eq} - I_b 30000 - 0.7 = 0 \\ & 10.0 - I_c 1000 - 5.0 = 0 \end{aligned}$$

$$\text{Active Region: } I_c = 150I_b$$

Solving these equations with Maple yields $V_{eq}=1.70V$. We now want to choose R_1 and R_2 so that V_{eq} is 1.70V. This yields the equations:

$$\begin{aligned} \frac{10R_2}{(R_1 + R_2)} &= 1.70 \\ \frac{R_1 R_2}{(R_1 + R_2)} &= 30000 \end{aligned}$$

Solving these equations with Maple yields $R_1=171K$ and $R_2=36K$.



5Spice modeling yields a gain for this amplifier of approximately 25 at 5KHz.