ELECENG 3EJ4 Lab 3

Raeed Hassan
hassam41
McMaster University

December 12, 2020

Part 1

Q1.

1. The relationship between I_o and I_{REF} is dependent on the EBJ area of the two BJTs. As the two BJTs are the same, they have the same EBJ area and the relationship between I_o and I_{REF} can be described as:

$$I_o = I_{REF}$$

2. When I_{REF} is 1 mA, I_o is equal to 0.975 mA, or $0.975 I_{REF}$.

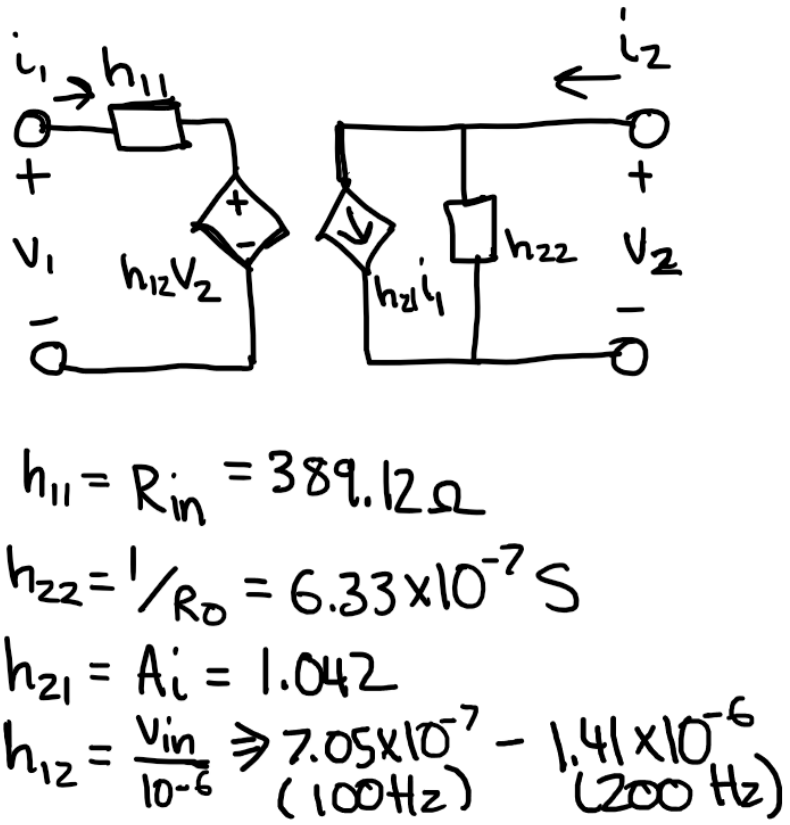
3. The values of I_o at $I_{REF} = 0.1$ mA and 1 mA are $1.04 I_{REF}$ and $0.975 I_{REF}$. The theoretical prediction and simulated results are similar, as the simulated results show that $I_o \approx I_{REF}$.

Q2.

1. The input impedance R_{in} is 389.12 Ω. The current gain A_i is 1.042.

2. The output resistance R_o is 1.58 MΩ.

3. The linear two-port network for the current mirror is shown in Figure 1.



$h_{11} = R_{in} = 389.12\,\Omega$

$h_{22} = 1/R_O = 6.33 \times 10^{-7}\,S$

$h_{21} = A_i = 1.042$

$h_{12} = \frac{V_{in}}{10^{-6}} \Rightarrow 7.05 \times 10^{-7}$ (100 Hz) $- 1.41 \times 10^{-6}$ (200 Hz)

Figure 1: Linear two-port network for the current mirror using its h-parameters

Part 2

Q3.

1. The voltage gain A_d is 70.07 dB.
2. The measured voltage gain A_d is 58.1 dB. There was a slight mismatch. The offset voltage applied at V_2 was 1 mV.

Q4. The upper 3-dB frequency f_{H} is approximately 11.2 kHz.

Q5. The upper 3-dB frequency $f_{3\mathrm{dB}}$ of the differential amplifier using resistive loads in Lab 2 was 8.4 MHz, much greater than the differential amplifier with a current mirror in this lab. The differential amplifier with the current mirror load has a smaller $f_{3\mathrm{dB}}$ due to the internal capacitive effects of the BJTs used in the current mirror load.

Q6. The gain-bandwidth product of the differential amplifier with the current mirror load is 151.1, while the gain-bandwidth product of the differential amplifier with the resistive load is 152.0.

Appendix

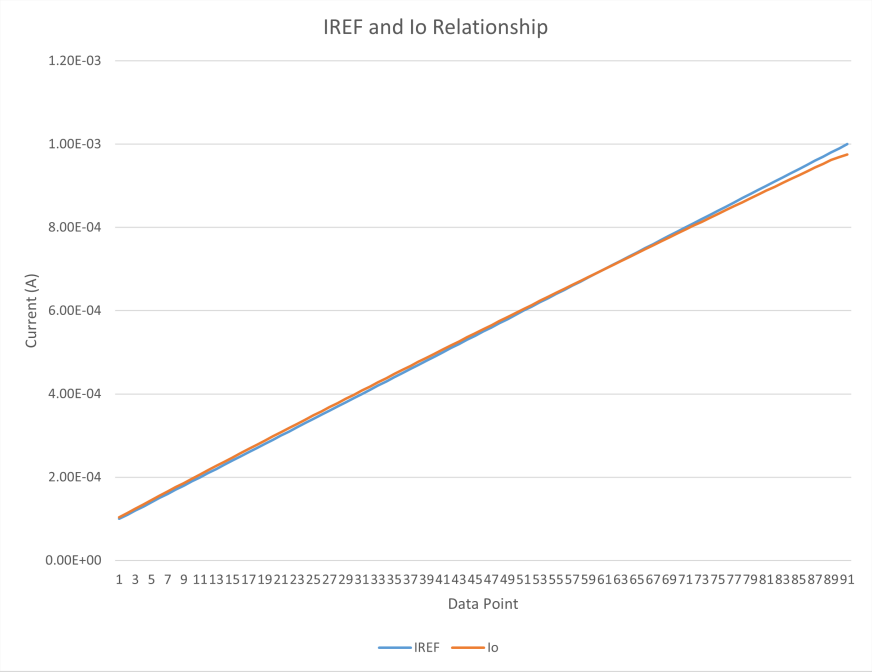


Figure 2: Step 1.2

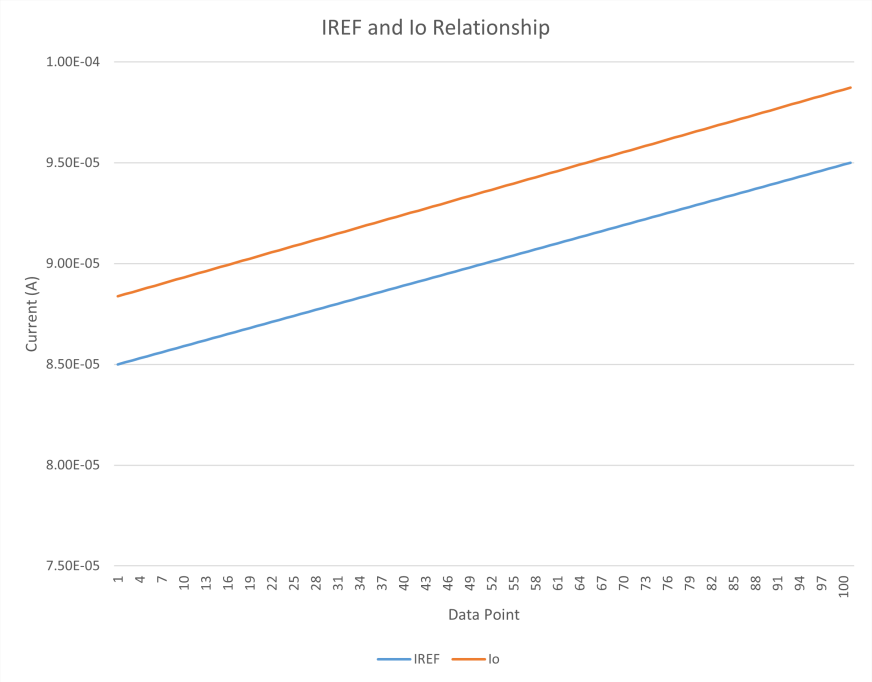


Figure 3: Step 1.3

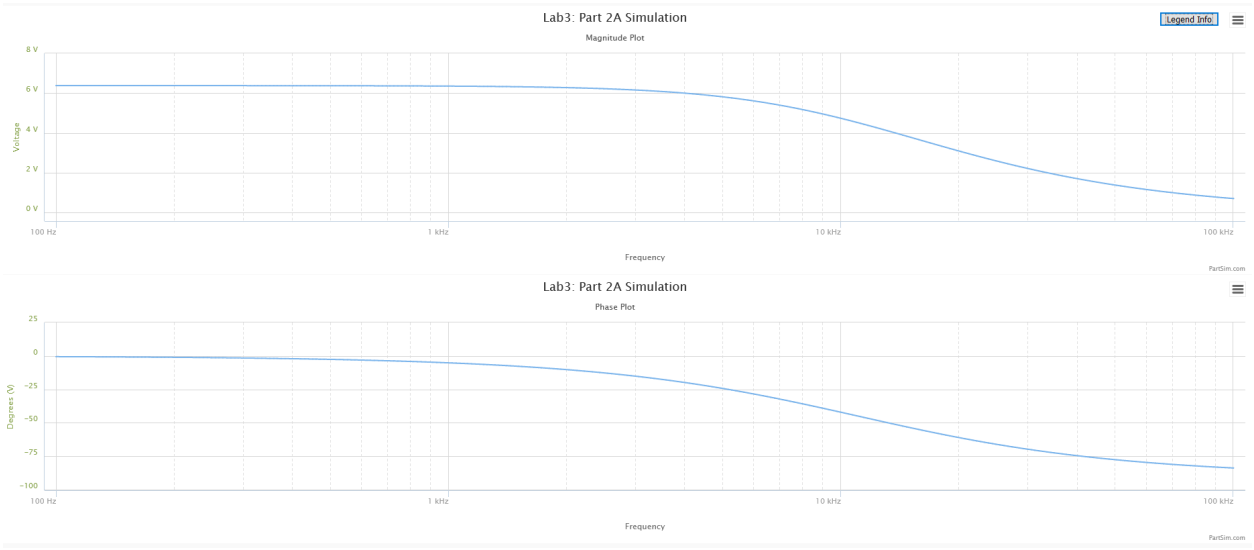


Figure 4: Bode plots for Part 2A

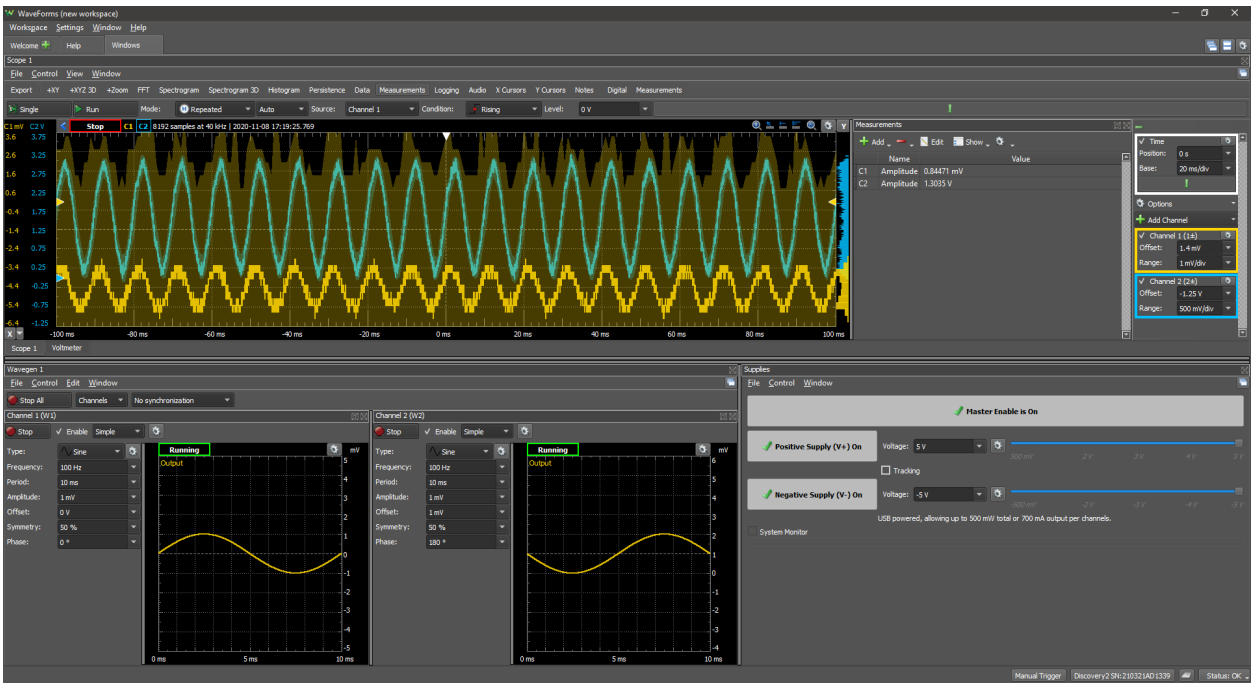


Figure 5: Waveforms Window for Part 2B

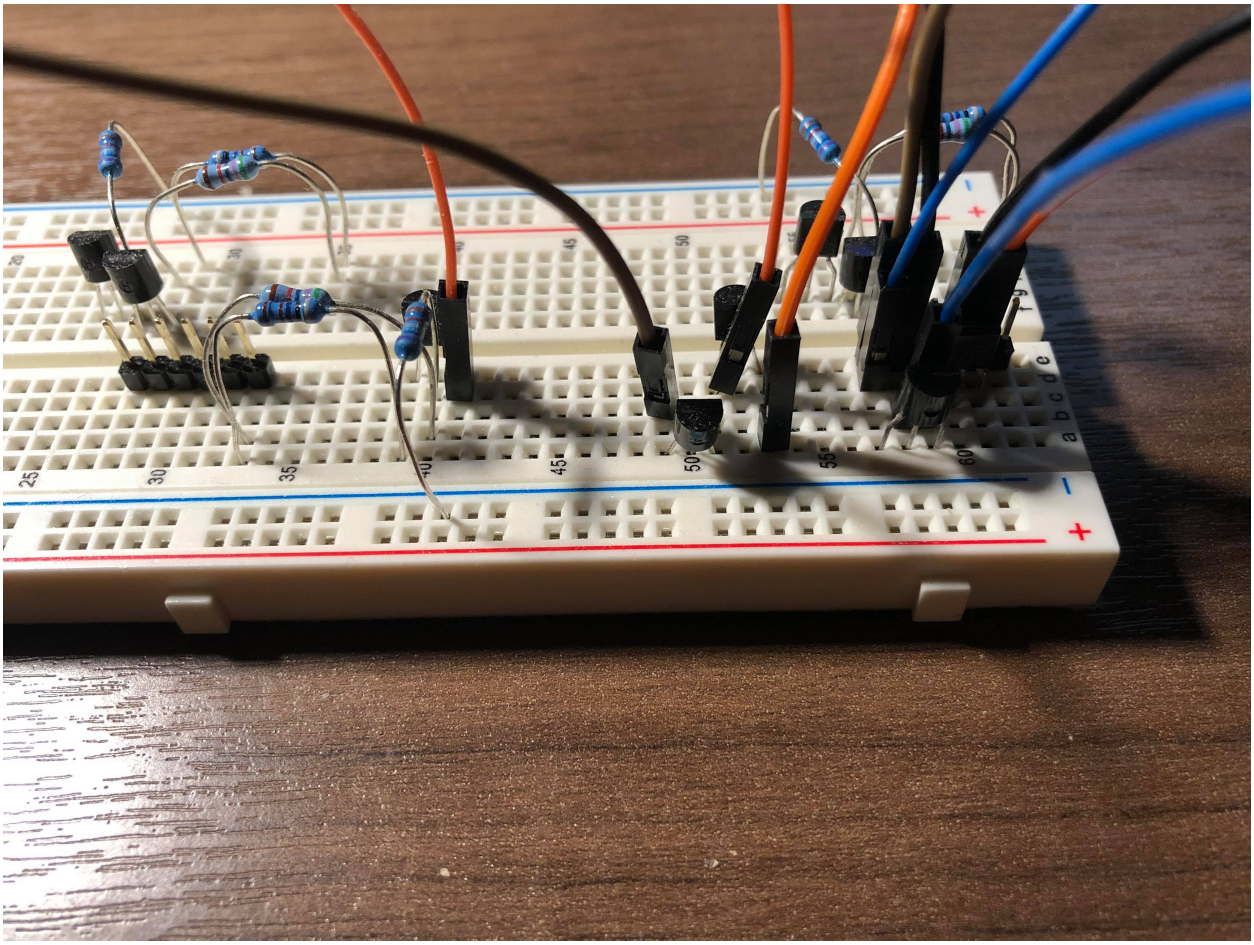


Figure 6: Circuit for Part 2B