In this lab you will build measure frequency responses of amplifiers and compare them against approximations. The learning goals are listed below:

- See the full frequency response of an amplifier and appreciate its complexity
- Understand how well the Miller approximation and exact models work
- Extract common parastiics that matter at high frequencies
- Take advantage of the Miller effect to modify impedances in interesting ways

# 1 Breadboard Parasitics

1. Find the row-to-row capacitance of your breadboard.
2. Find the row-to-rail capacitance of your breadboard.

# 2 Common Emitter Frequency Response

1. Build two common emitter amplifier with gains of 50 and collector currents of 1mA. Use the same design for both (i.e.: same $R_c$, $R_e$, $C_e$, etc.), but lay them out on your breadboard differently as shown in Figure 1: one device has its terminals on adjacent rows while the other has the rows between terminals grounded.
2. Calculate the voltage gain transfer function of the common emitter using the exact expression derived in lecture and using the Miller Approximation. Plot Bode plots for both transfer functions.
3. Measure a Bode Plot for each amplifier out to as high a frequency as possible. Try to capture the second order pole and the feed-forward zero.
4. Compare the frequency response of your models to your experimental data from your amplifier which was laid out with layout B.
5. Compare the frequency response of layout A for your amplifier to layout B for your amplifier. Explain the differences.
6. Measure the step response of the amplifier and explain its features. How can you measure a step response when your input is AC coupled? Does the amplifier step response appear to be first or second order? Does the feed-forward zero appear in the step response?

# 3 BONUS POINTS – Gyrate a capacitor

1. Build a non-inverting amplifier with a gain of at least 10. You can connect your CE amplifiers in series or use an op-amp. Connect a 10 nF capacitor from the output to the input of the non-inverting amplifier. Put a capacitor in series with this gain stage. Measure the step response of the circuit and explain your results.

   *H*int: Think about the Miller Effect and the sign of inductive and capacitive impedances.

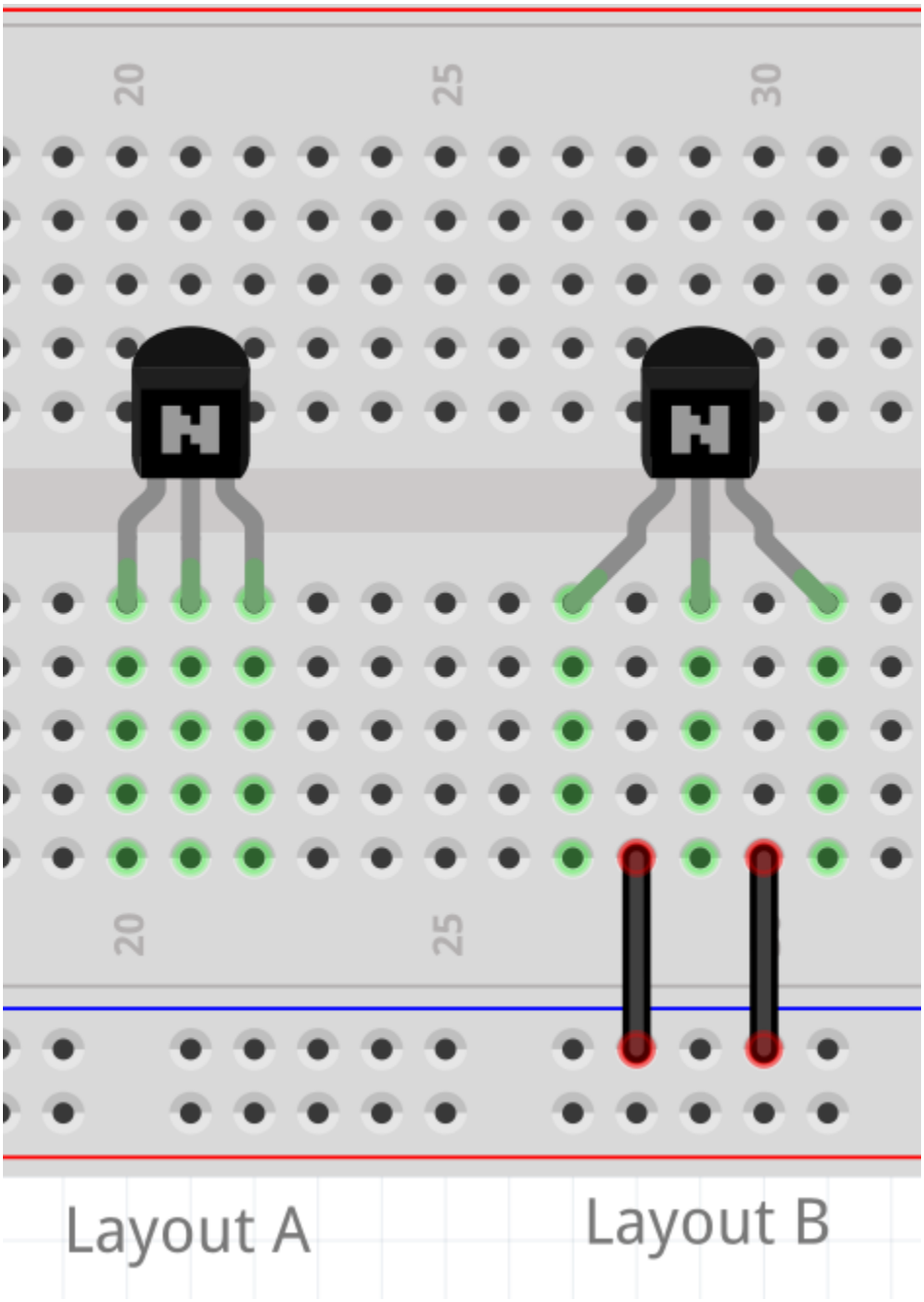


Figure 1: Different layouts for transistors.