CE 3111.103

Lab 5: BJT Amplifiers – Part II

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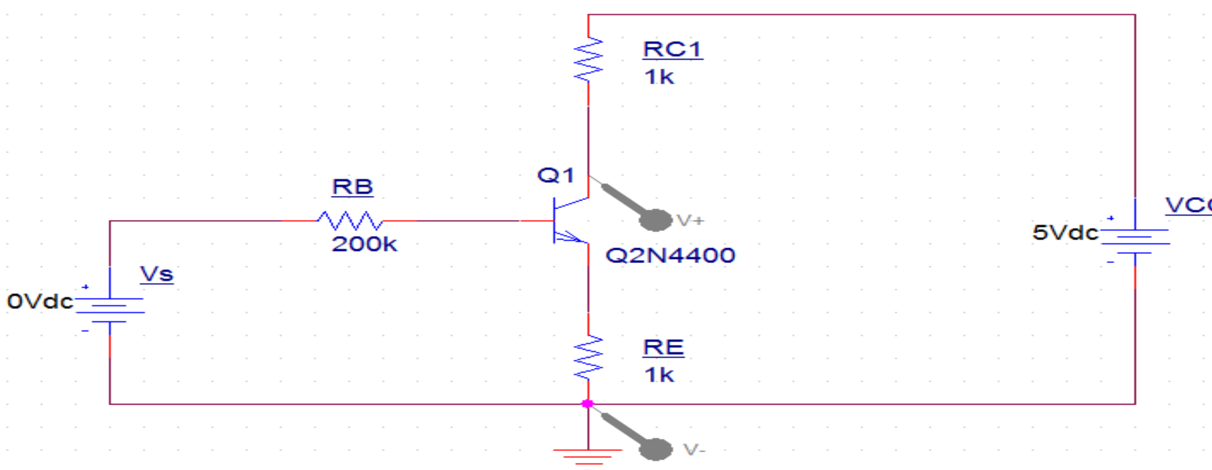
Objective

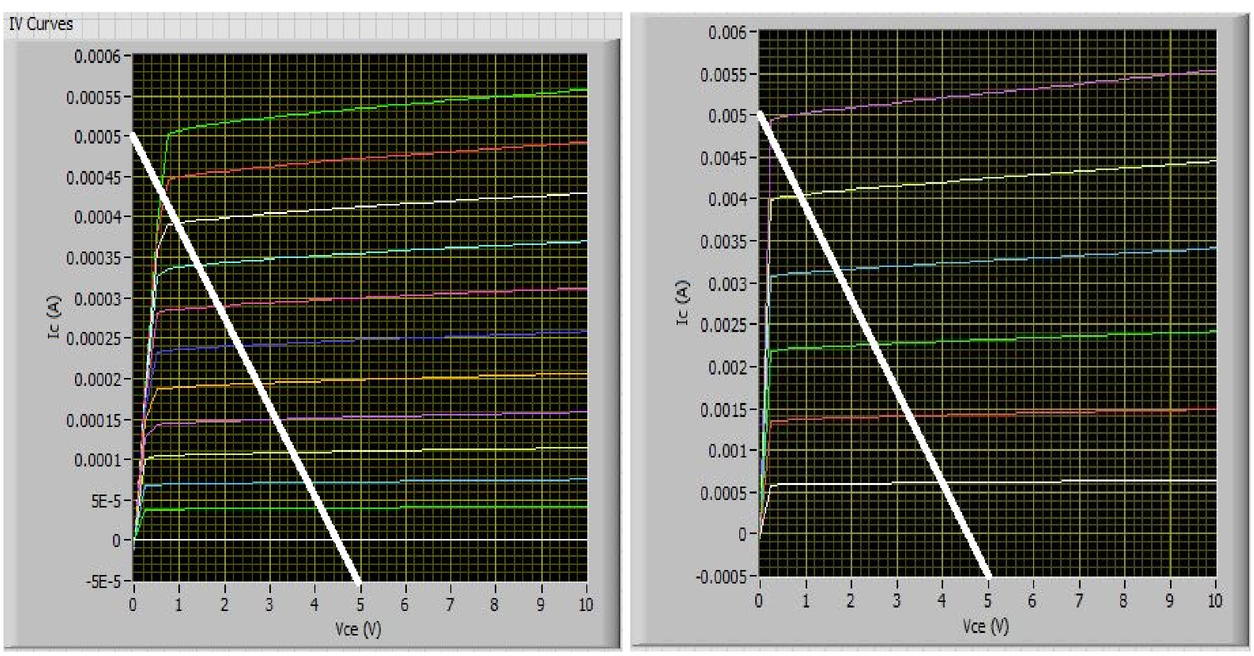
Compare behaviour of CEED with CE configuration. Look at amplifier's response, mid-band gain, and low and high cut-off frequencies.

Experimental Results

- CE with Emitter Degeneration
    1. PSpice circuit

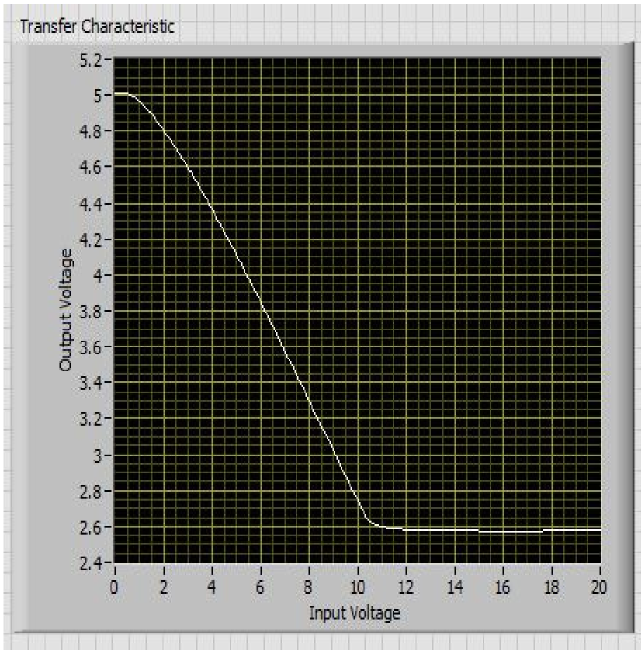


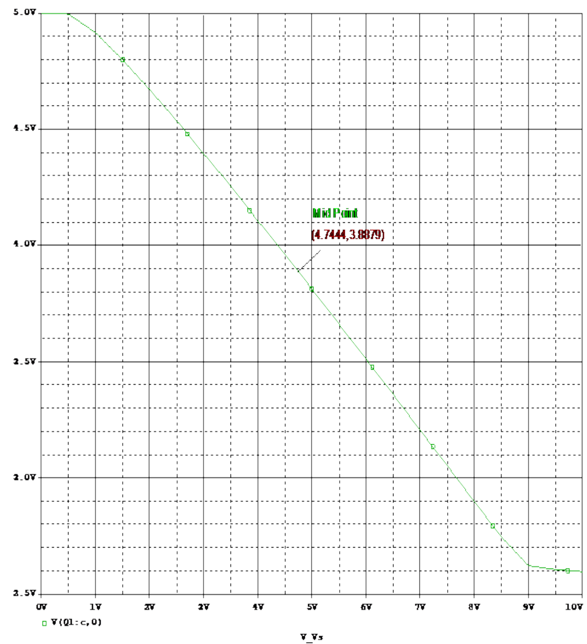
    2. Load line: $I_C = \frac{5V - V_C}{10k\Omega}$



- Left: I-V curve of CEED. Right: I-V curve of CE
- The additional Re caused the Ic 10 times smaller than without it.

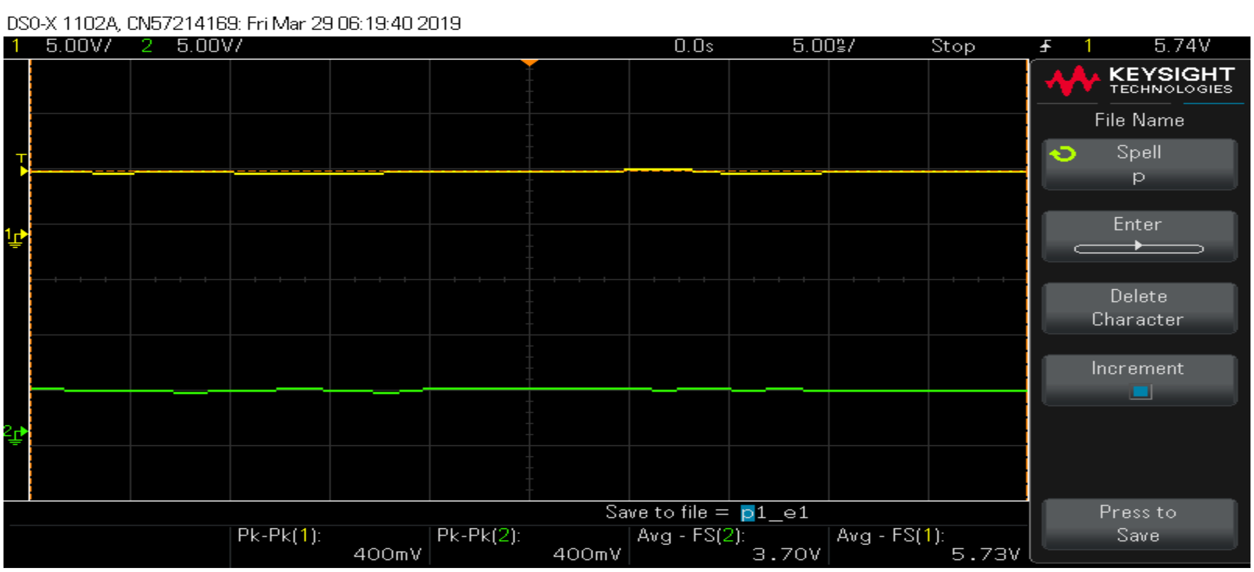
3. Transfer function





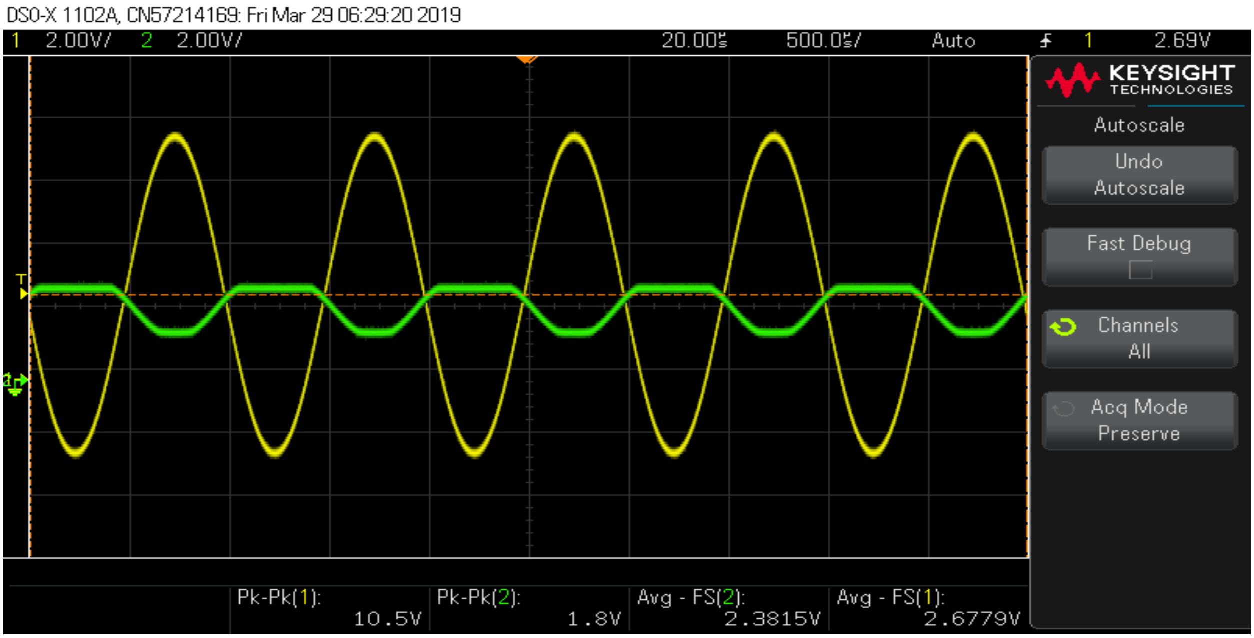
- Left: Experimental result Right: Simulation result
- ($V_{in,min}$, $V_{out,max}$)=(0.6,4.99)
- ($V_{in,max}$, $V_{out,min}$)=(10.5,2.62)
- ($V_{in,middle}$, $V_{out,middle}$)=(5.55,3.87)
- Gain, experiment=$\frac{3.87-4.1}{5.55-5} = -0.41818$
- Gain, Simulation=-0.2977

4. Small signal Voltage gain



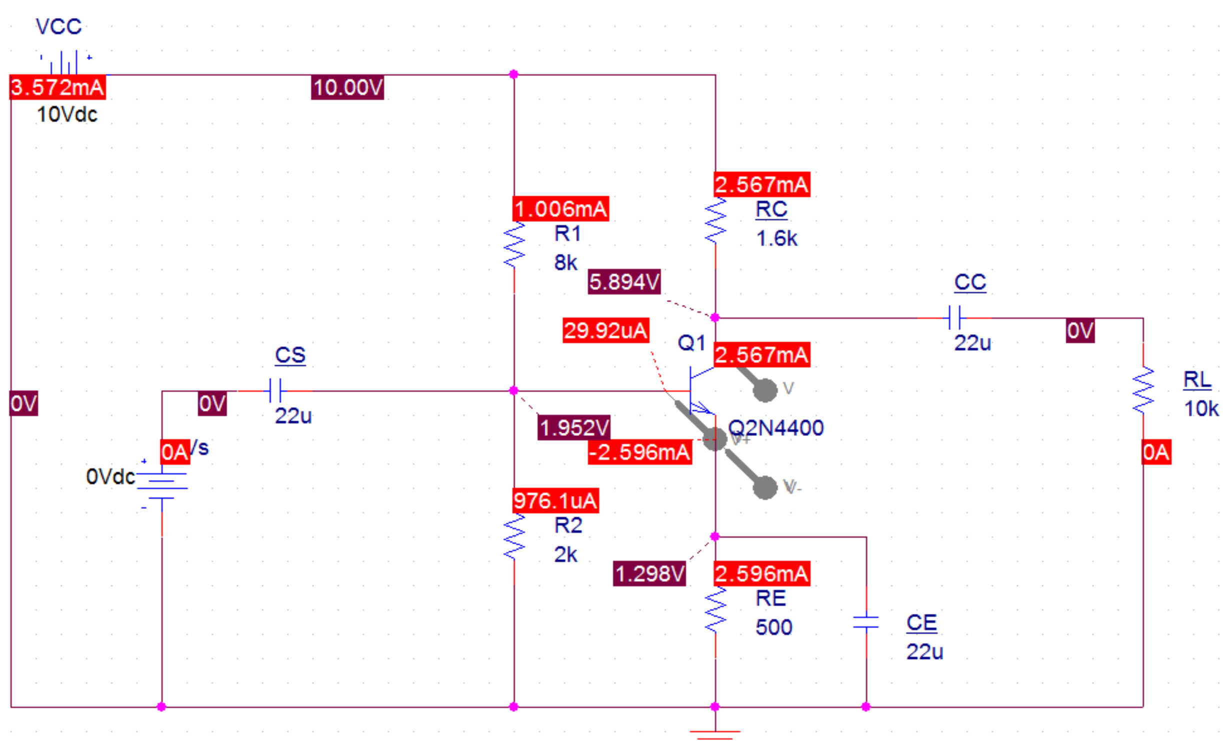
- AC Gain = $\frac{V_{out}}{V_{in}} = \frac{3.70}{5.73} = 0.64572$

5. Clip

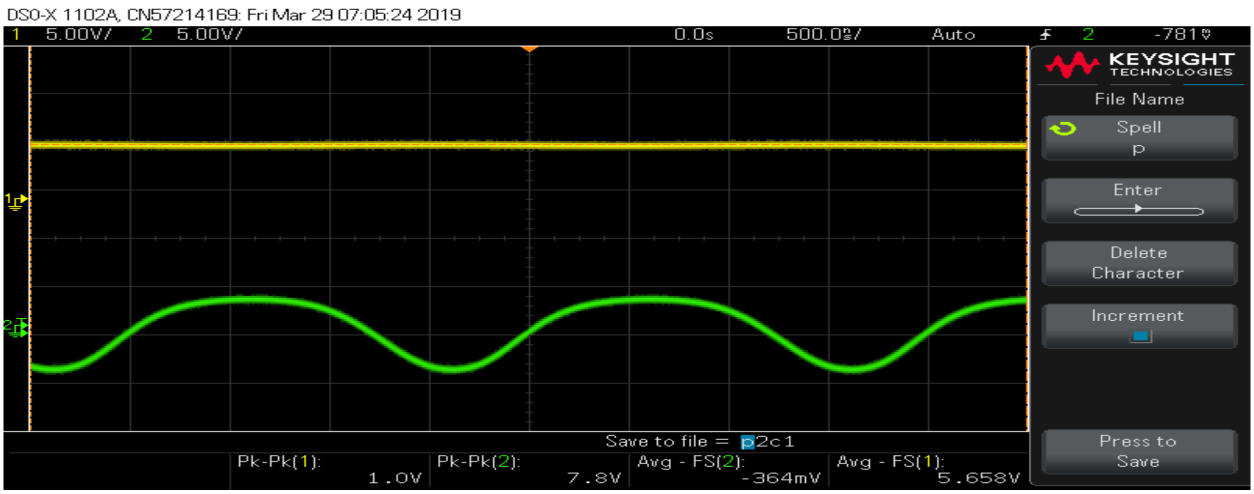


Clipping occurs because of the negative gain characteristic of the amplifier, and the transfer function rules the V_{out} decreases as V_{in} increases.

- CE amplifier with bias circuit and AC-coupled I/O
  1. PSpice circuit

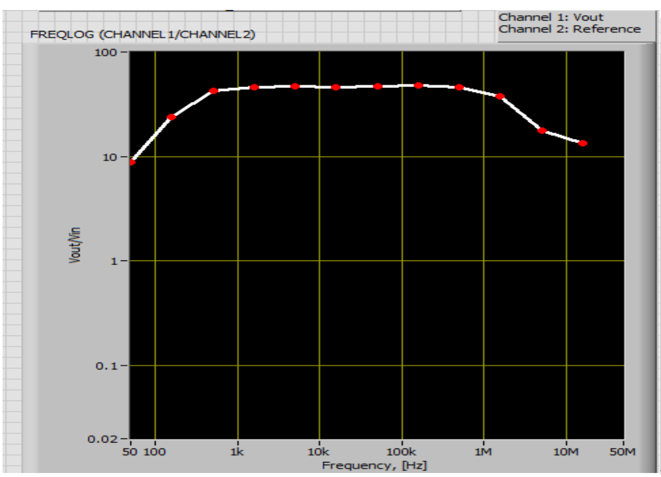


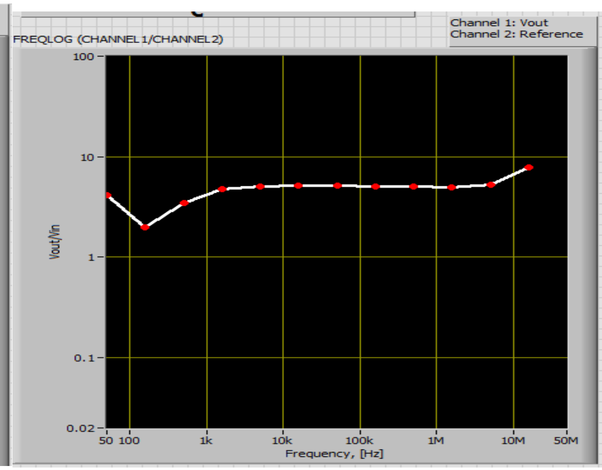
2. Small signal voltage gain



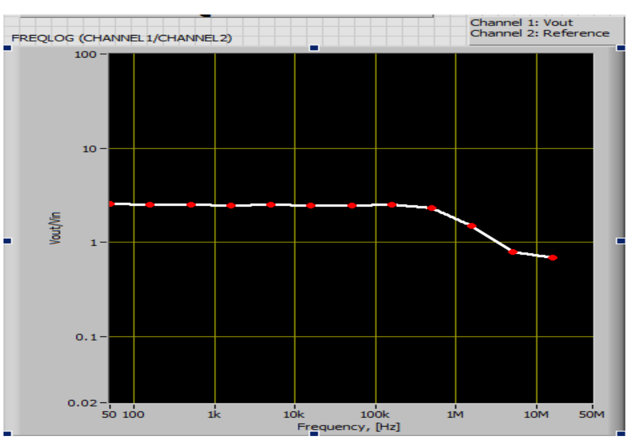
- Gain=$\frac{V_{out}}{V_{in}} = \frac{-364mV}{5.658V} = -0.06433$

3. Bode plots
   - Left: Original Right: R_L reduction





   - C_E removed

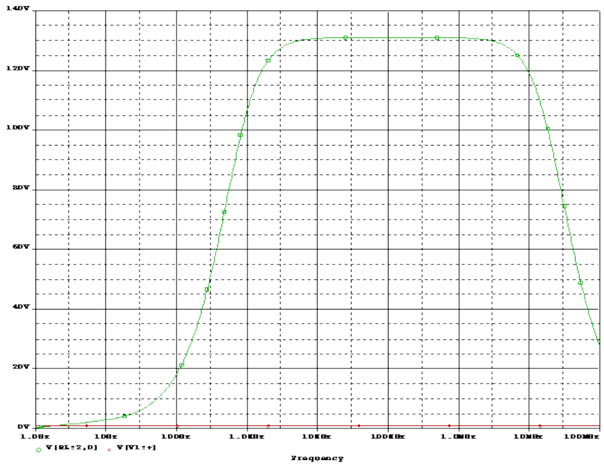


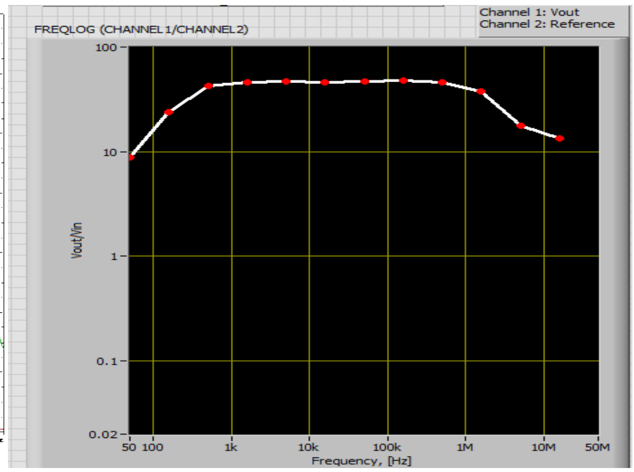
Due to instrumental error, graphs may not be accurate

- When R_L is small, it dominates the mid-band gain.
- When C_E is removed, R_E dominates the mid band gain through gm.

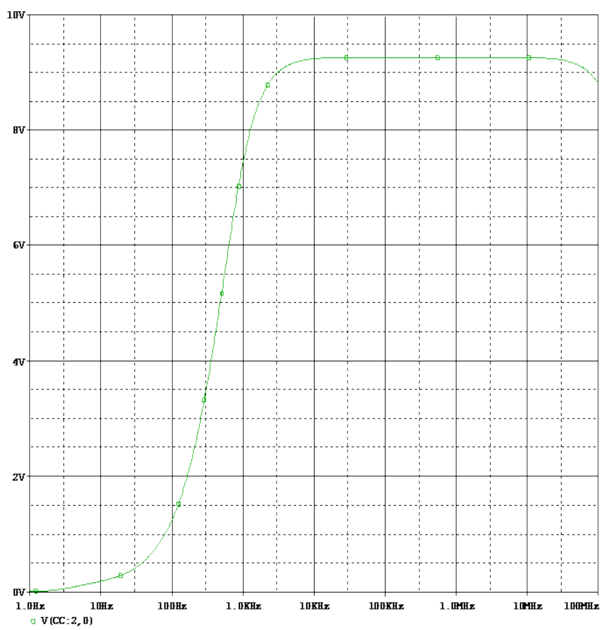
Analysis Question

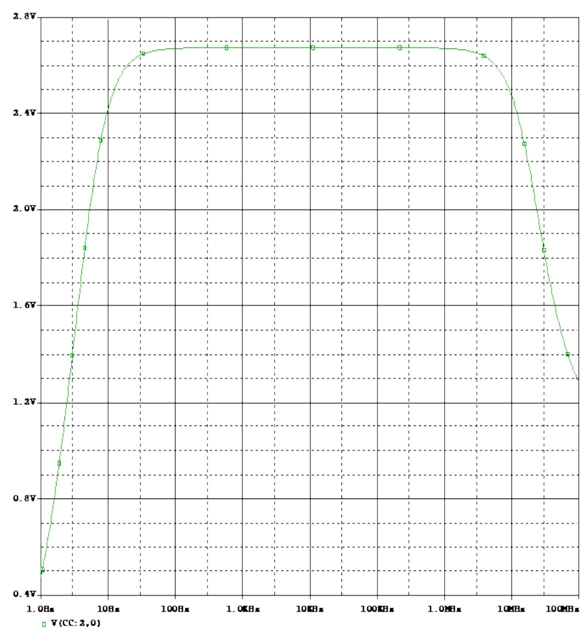
1. The additional R_E caused the output voltage to be smoother. It also decrease the gain a little bit.
2.
   a. The experimental graph shows only the top part of the actual response.





   b. Left: smaller R_E Right: removed C_E. The simulation has discrepancies to the experimental result due to errors occurred in oscilloscope. The gains from both modification to the amplifier decrease due to the maximum output voltage decrease.





   c. $A_{mid,original} = -\frac{0.19mA}{26mV} \times \frac{1.6k \times 10k}{1.6k+10k} == -10.0796$

$$A_{mid,new\ load} = -\frac{0.19mA}{26mV} \times \frac{1.6k \times 100}{1.6k + 100} = 0.68778$$

Calculation matches measurement.

3. The smaller the R_L, the smaller the amplifier gain. The bigger the R_E, the bigger the amplifier gain through gm.
4. R_E affects G_m, R_π of the small signal model. The effect can be made positive in terms of restricting the output voltage, making it stable. R_E must be chosen in the FAR region of BJT, so $V_{CE}>V_{BE}$. It serves the origin of CEED circuits, which is to stabilize the output.