CE 3111.103

Lab 3: BJT Digital Switch

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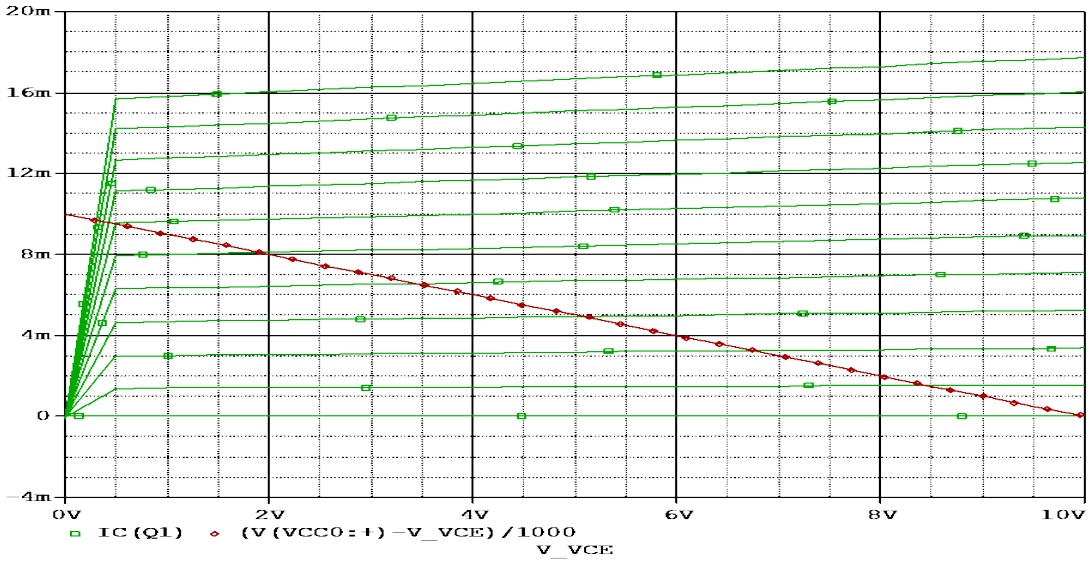
Objective

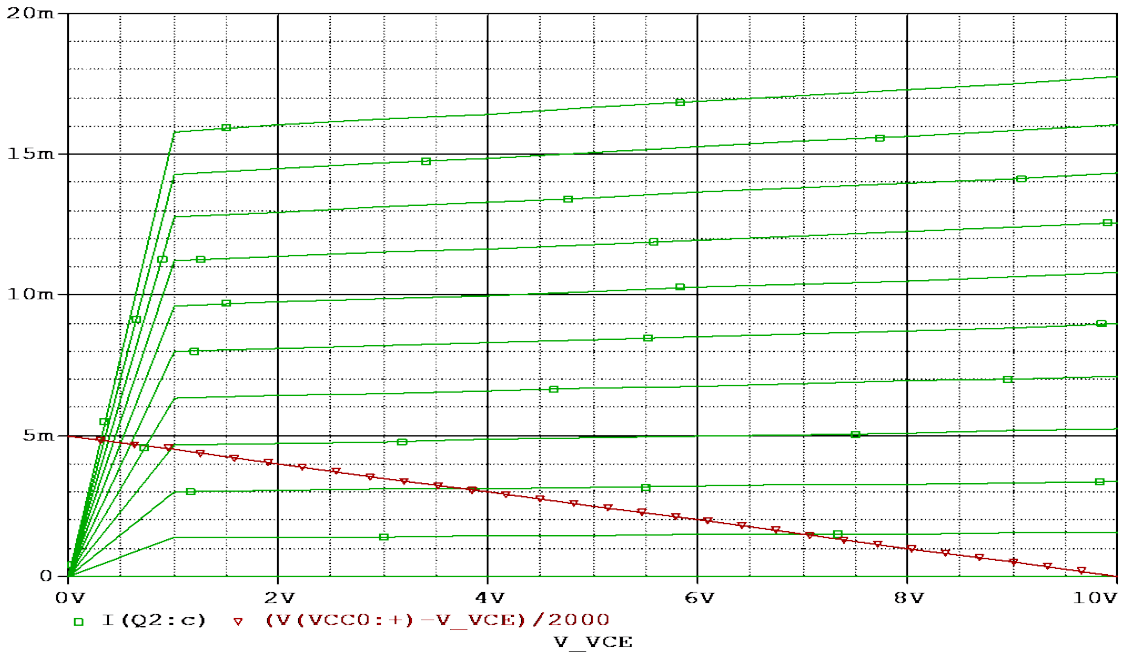
Acquaint with the basic operation of the bipolar junction transistor and its functionality in digital switching circuit.

Experimental Results

- BJT inverter
    - Simulated I-V & load line
        - 1kΩ



        - 2kΩ

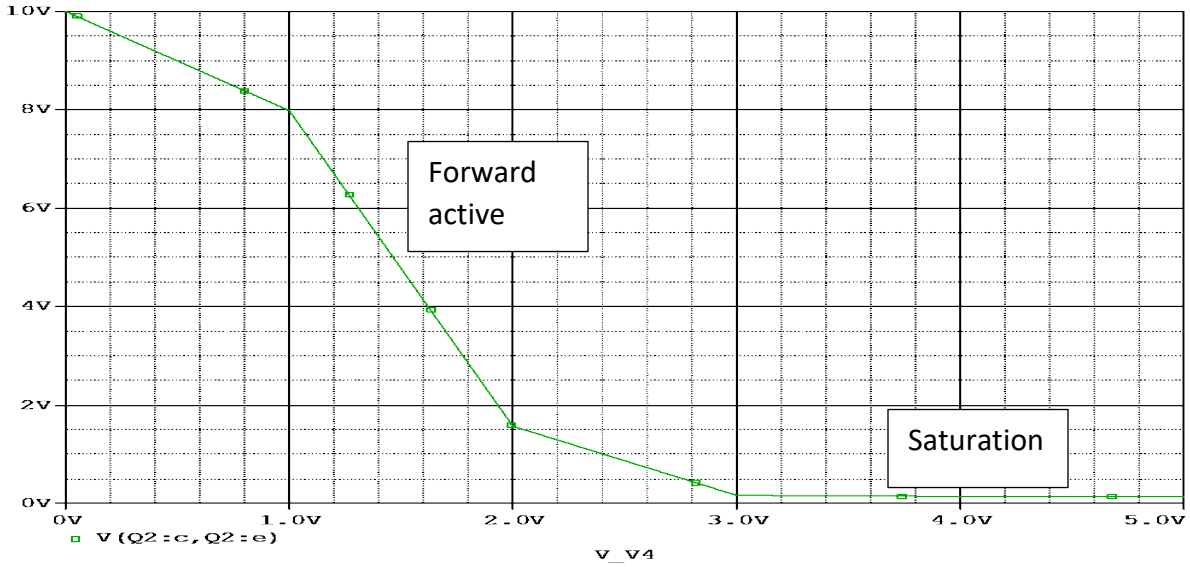


- Because that is the point where Vce and Vcc are the same, making the collector current zero. At that point, the BJT is not operational.
- Calculation of R_B
  - $2.5\text{V} = 10\text{V} - 100\frac{2000\Omega}{R_B}(2.5V - 0.7V)$
  - $-7.5 = -\frac{200000}{R_B}(2.5V - 0.7V)$
  - $-7.5 = -\frac{200000}{R_B}(1.8)$
  - $R_B = -\frac{200000}{-7.5}(1.8) = 48000\Omega$
  - $R_B$simulation: approximately $48k\Omega$

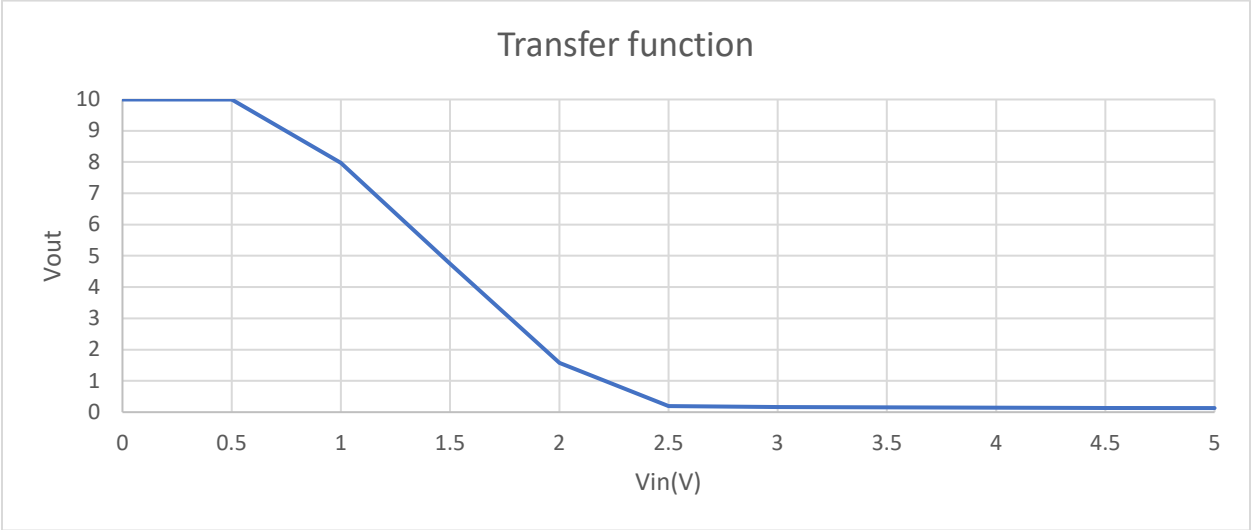
Cutoff

Transfer function graphs

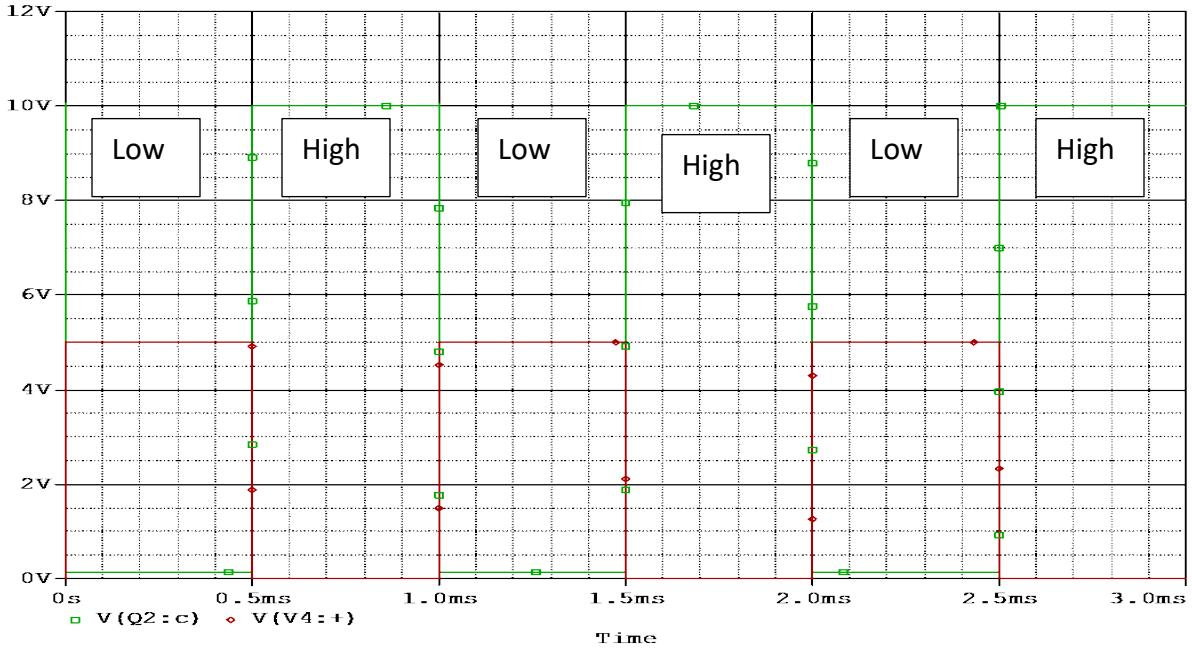
- Simulated



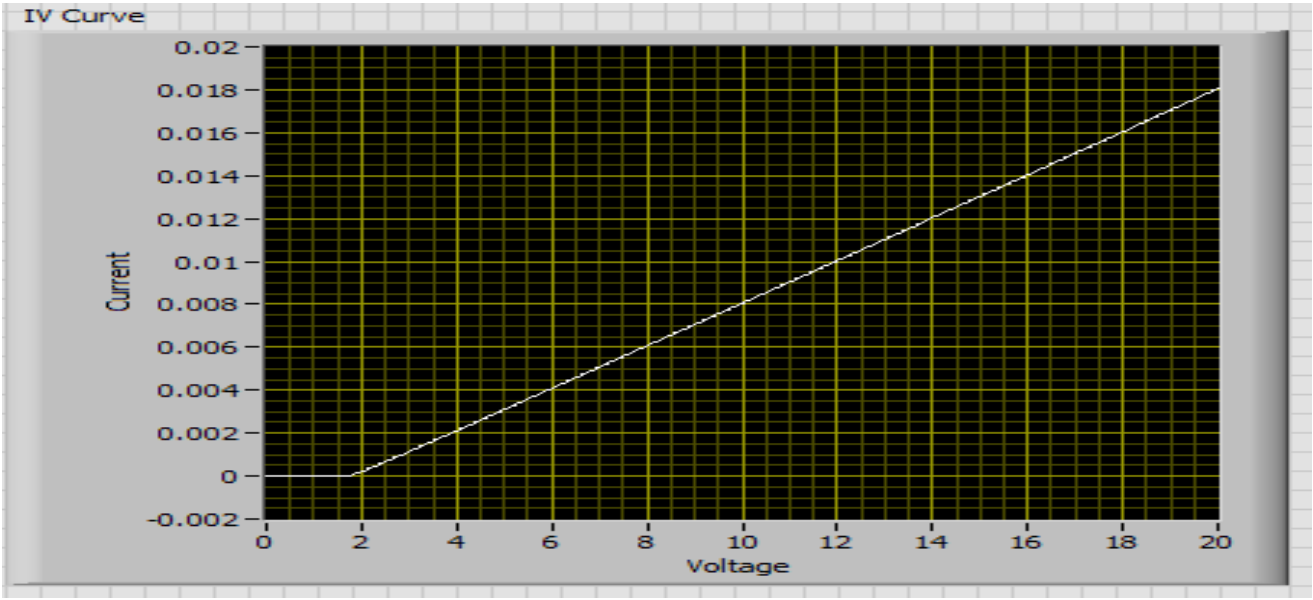
- Measured



- Transient simulation



- I-V characteristic of the LED-resistor pair



- Inverter's input and output waveform
  - Channel 1: input; Channel 2: output
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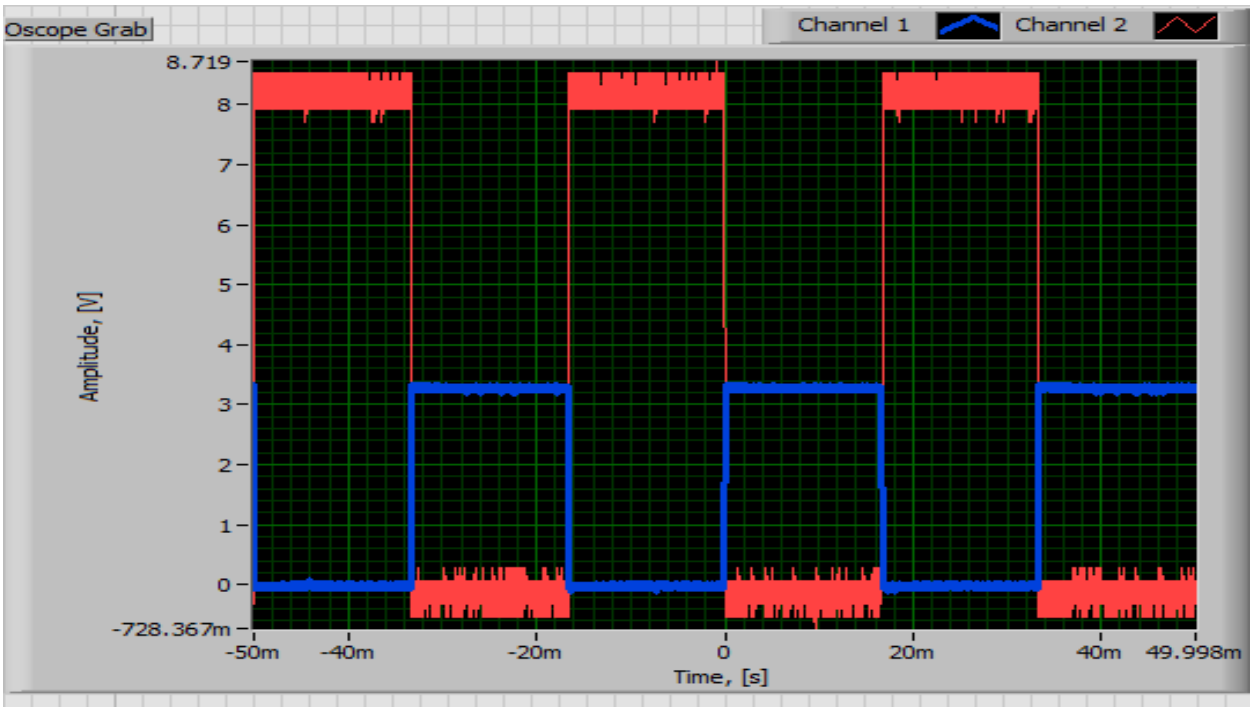
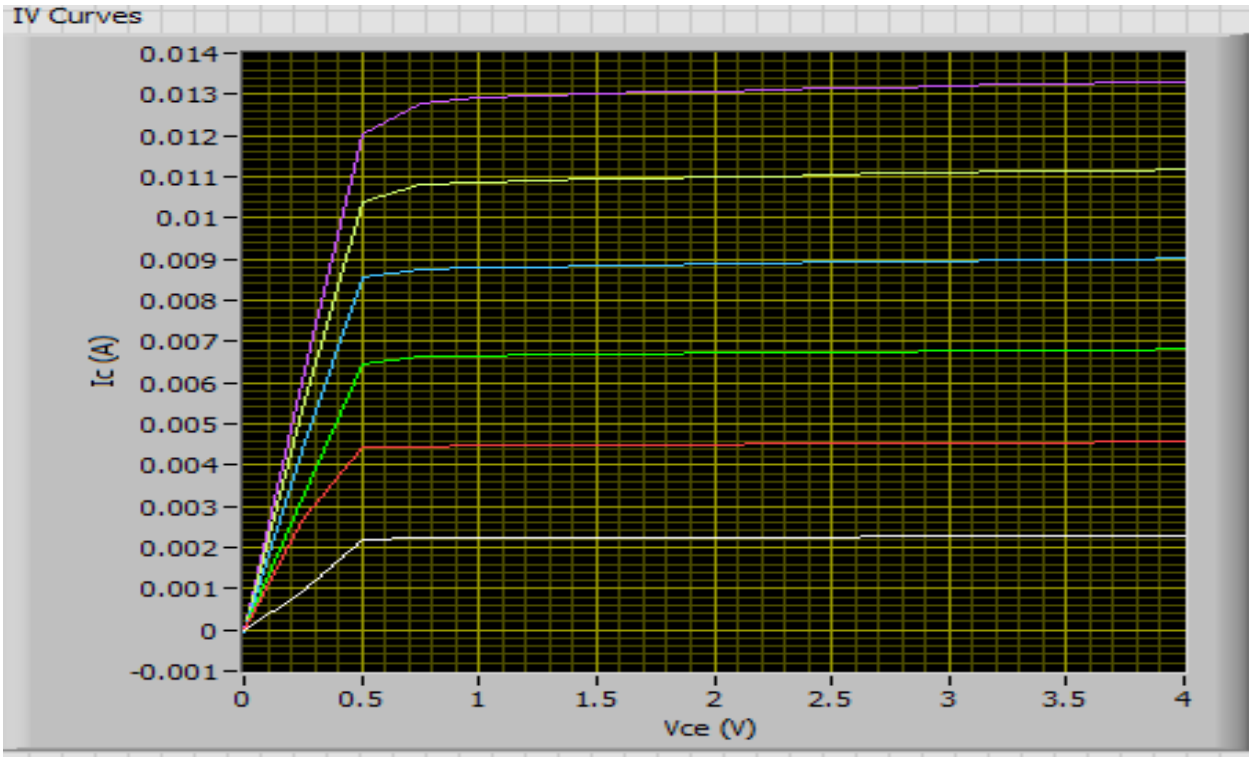
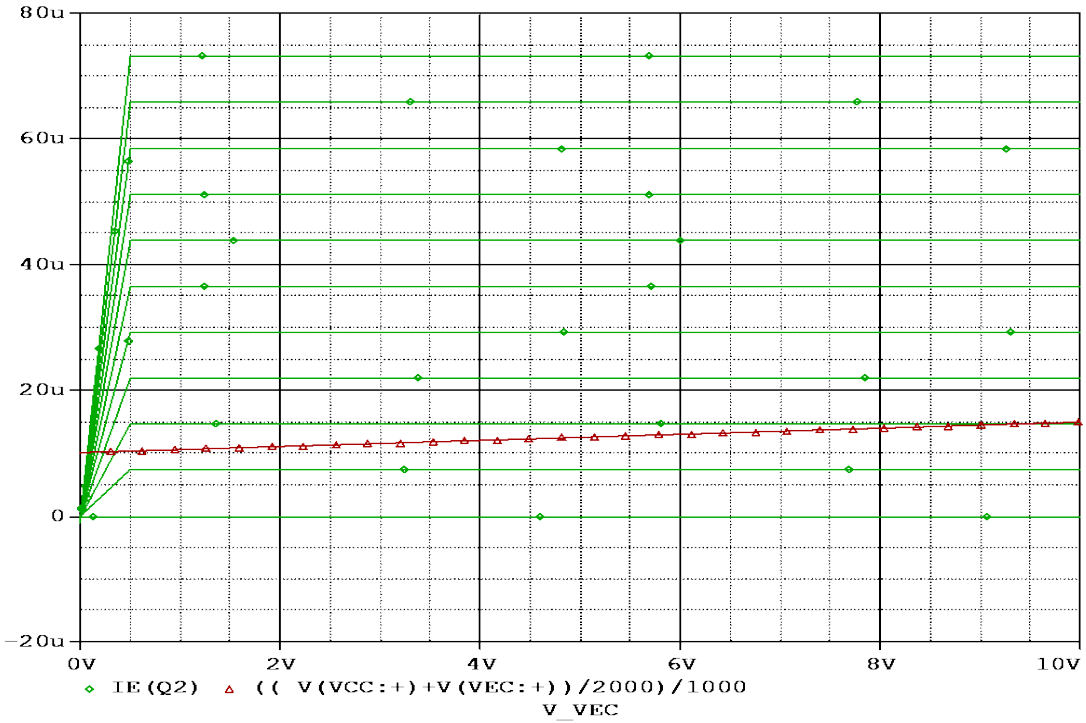


- BJT I-V curve

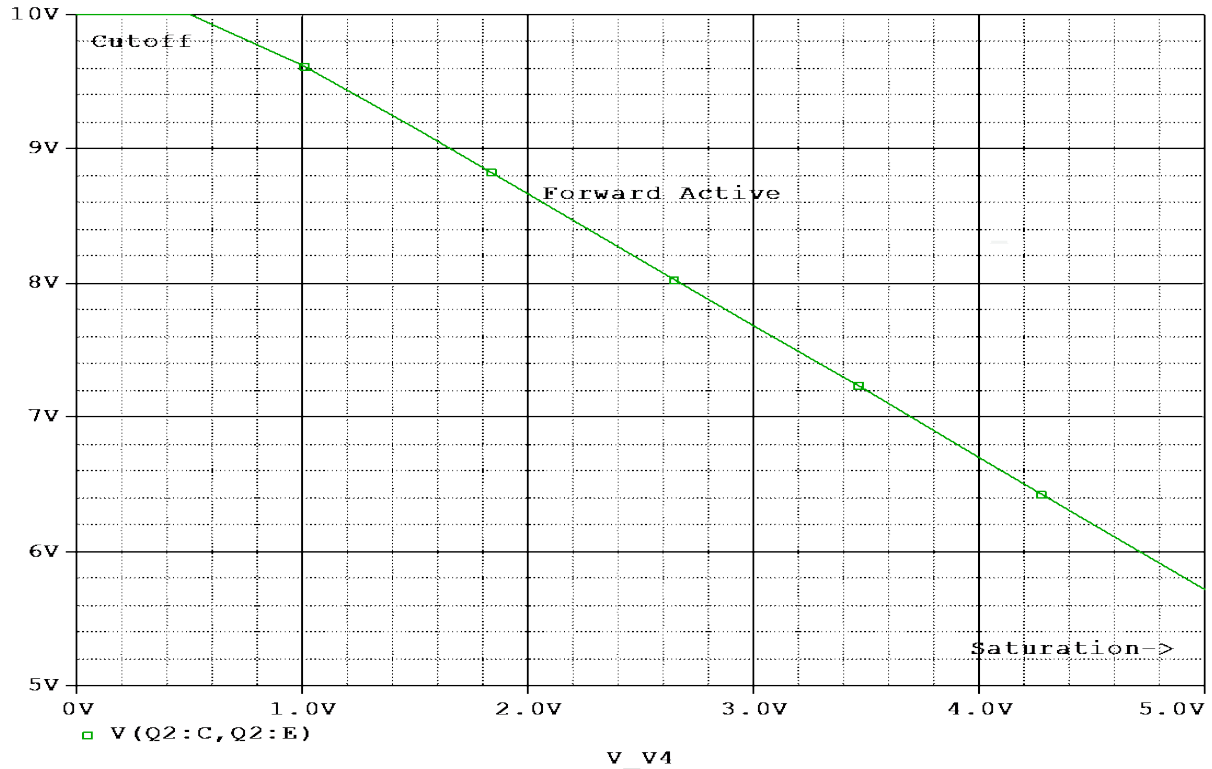


- BJT follower
  - Load line equation:
    - $I_E = \frac{V_{CC}+V_{EC}}{R_E}$

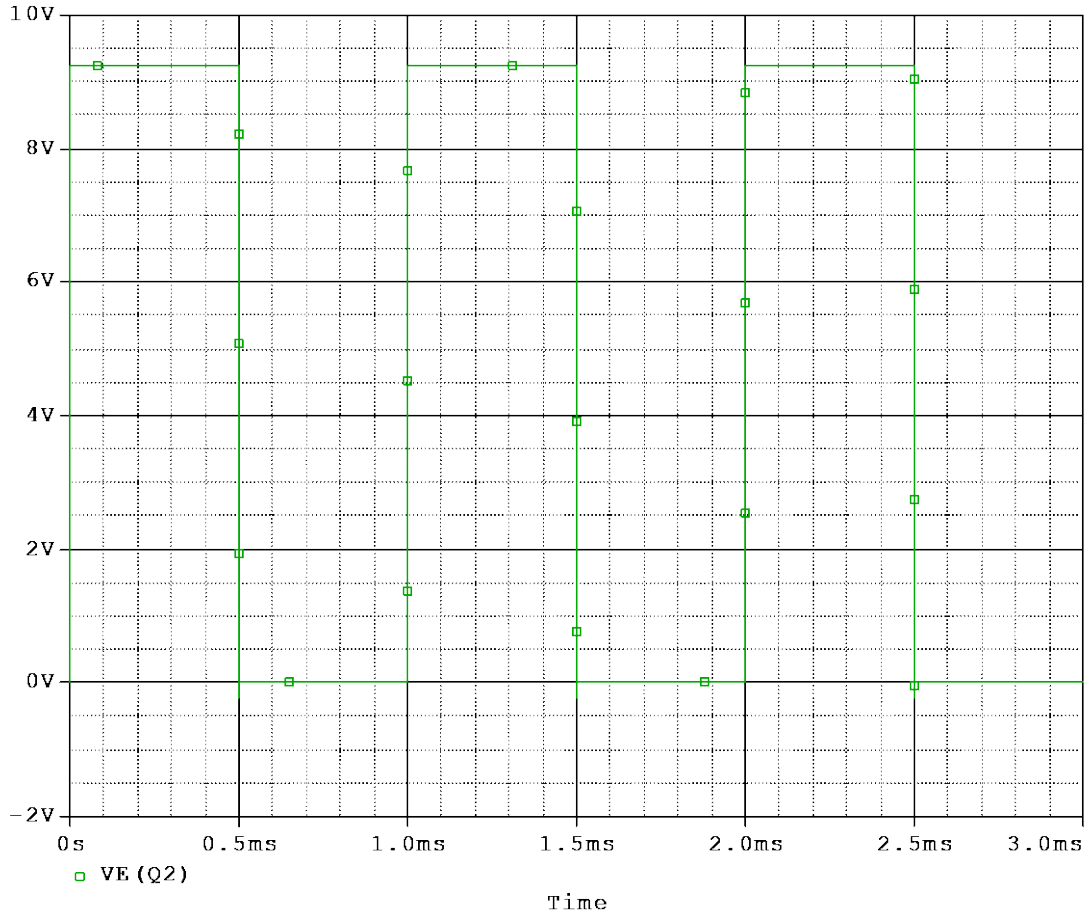
- Simulated I-V and load line curve



- Transfer function graph



- Transient simulation



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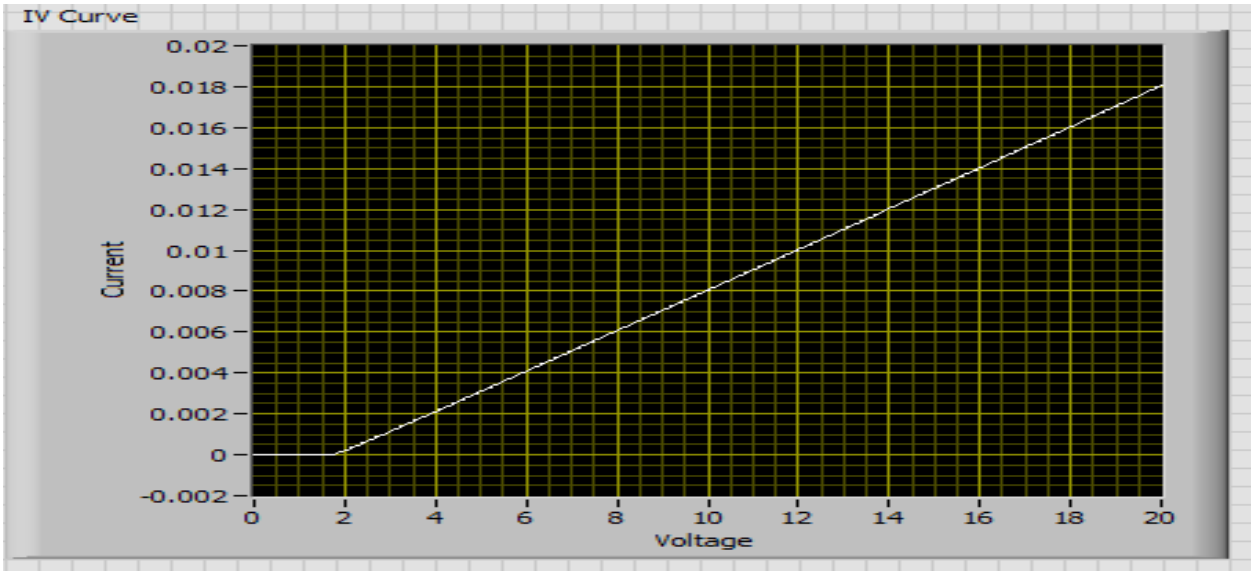

- Follower's input and output waveforms
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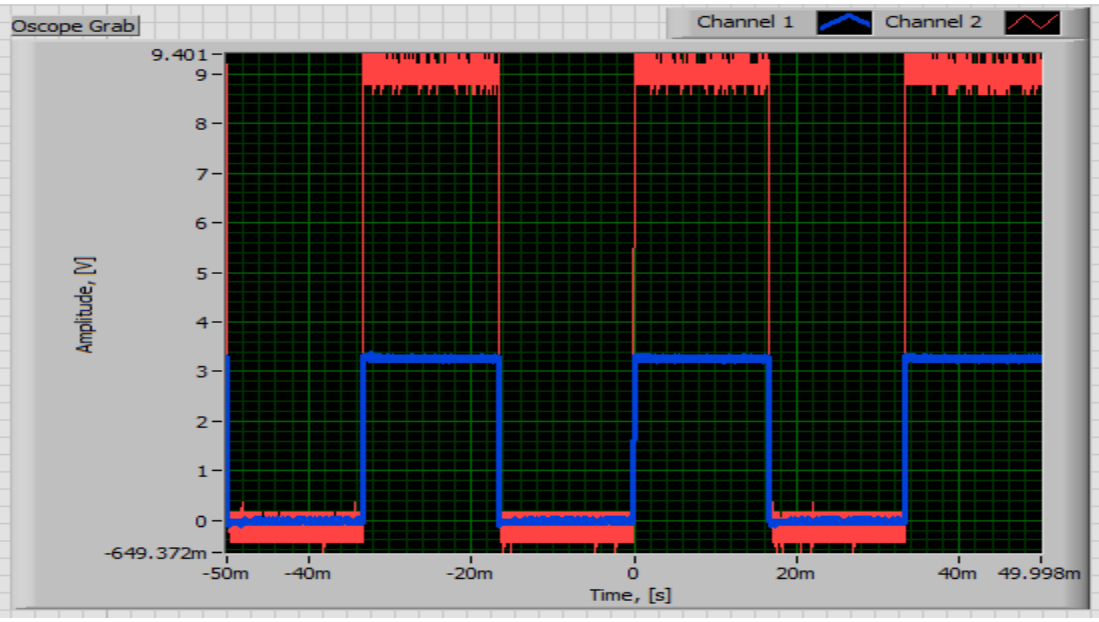

Comparison

	Simulation	Experiment
Vpp, inverter	9.3V	9.4V
Vavg, inverter	4.65V	4.013V
Vpp, follower	9.23V	10.5V
Vavg, follower	4.615V	4.429V

I-V curves, Transfer function, transient results match closely to their corresponding simulation results.

Thought question

1. Use of resistor plus a diode ensures the Base-Emitter region is always forward biased, so the BJT is always in forward biased region. Using a diode (LED) can also limit the emitter voltage so that emitter current is only allowed after reaching the diode's turn on voltage.

Conclusion

Experiment results closely match the simulation result. Due to diode's effect, when the inverter and follower circuit at a low position, it fluctuate around 0 instead of staying flat at 0.