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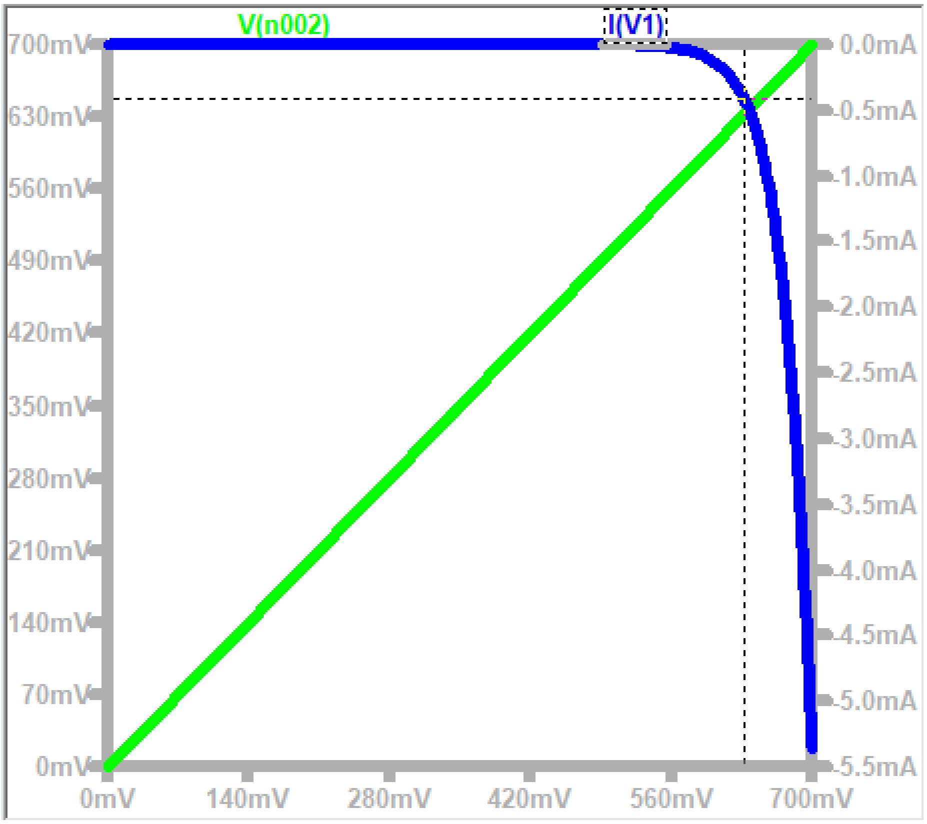
IE lab 4 part1

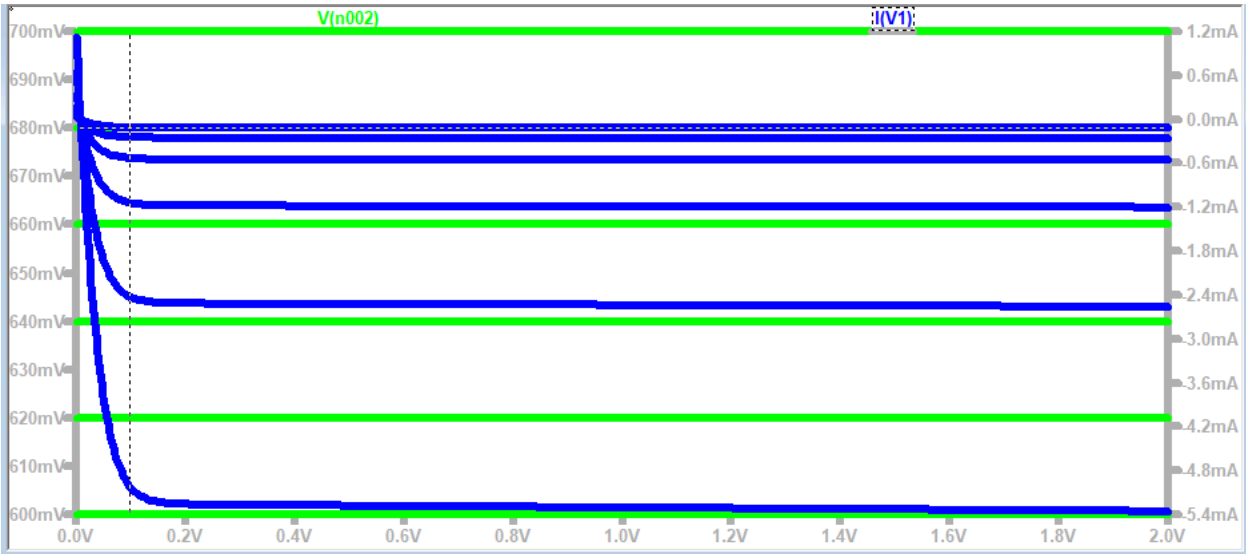
Pre Lab Exercise 1:
For the PSpice simulations, the transistors are Q2N2222 and for the experimental portion, the transistors are PN2222.

1) Build the circuit shown in Figure 1 (below) in PSpice. Both sources are of type VDC. Set VCE to 2 V and under the simulation profile set VBE to the Primary Sweep with voltage range 0 < VBE < 0.7 V. Generate a plot of IC-versus-VBE.
   On the plot, indicate the regions where the BJT is OFF and where it is ON.
   Approximately, at what base-emitter voltage does the transistor turn ON. Is this consistent with diode characteristics?



Using the 2N2222, the BJT is off on the left, and turns on around .63V.
Yes, this is approximately an Si diode characteristic.

2) Change the Primary Sweep to VCE, setting the voltage range 0 < VCE < 2V. Set VBE to the Secondary Sweep with voltages VBE → {0.6, 0.62, 0.64, 0.66, 0.68, 0.7 V} and plot IC-versus-VCE.
   On the plots, identify the saturation region and the forward active region. Approximately, at what voltage is the transition from saturation to forward active. Is this value approximately consistent with your expectations?



The saturation region is on the left, and becomes the active region on the right around VCE=0.1V

This is approximately consistent with expectations, once VBE has turned on the BJT, the thin layer will have very little resistance..

Exercise 1:

1. Construct the circuit shown in Figure 4 (below) using the +25 V channel on the E3631A power supply for V1. Set V1 to the DC voltage of 7 V.
   In the following, measure the DC voltages across and currents through (using Ohm's law) RC and Rb. Use the benchtop multimeter to make the DC measurements.

2. Starting at V2 ≈ 2.0 V, slowly increase V2 until the BJT collector current IC is 20 mA. Determine the base current IB by measuring the voltage drop across the 22 kΩ base resistor. Measure VCE and verify that the device is in the forward active region. Measure VBE.
   Is the VBE measurement close to our 0.7 V approximation value?

V(R100)=1.954V (Ic=19.54mA)

	Channel 1	Channel 2
DC	5.028 V	6.982 V

Positive Supply (V+) On | 2.75 V

V(R22k)=2.114V (Ib=0.09609mA)

	Channel 1	Channel 2
DC	2.764 V	650 mV

3. At the voltage determined in Part 2 (above), use your IB and IC measurements to estimate the common-emitter current gain β = IC / IB.

beta=19.54mA/0.09609mA=203.349

4. Raise V1 to 10 V and measure IC , VCE and VBE.
   Describe the changes you see. Did VBE change significantly?

V(R100)=2.16V (Ic=21.6mA)

	Channel 1	Channel 2
DC	10.03 V	7.87 V

V(R22k)=2.16V (Ib=0.09818mA)

	Channel 1	Channel 2
DC	2.764 V	622 mV

Ic changed from 19.54mA to 21.6mA (dIc= 2.06mA)
VBE changed from 650mV to 622mV (dVBE=28mV), not much signifigance
VCE changed from 6.982V to 7.87V (dVCE=888mV)

5. Use the two IC and VCE measurements to estimate the output resistance, rout , and the Early voltage, VEarly. The Early voltage can be calculated from the formula (to be discussed during lecture):
   slope=dIc/dVce=1/rout=Ic/(Vearly+Vce)~=Ic/Vearly

How do these values compare to the spec sheet values for the PN2222?

Keep the transistor that you used in this exercise for the remaining exercises. If you lose your transistor, use the above circuit to determine the transistor characteristics for the replacement transistor. You will need the values for the small signal analysis.

rout=888mV/2.06mA=431ohms

1/rout=Ic/(Vearly+Vce)

Vearly+Vce=Ic*rout

Vearly=Ic*rout-VCE

Vearly=0.01954A*431ohms-6.982V=1.441V

Vearly=0.02160A*431ohms-7.870V=1.441V

This is significantly less than the only value I was able to find online, ~75V-100V