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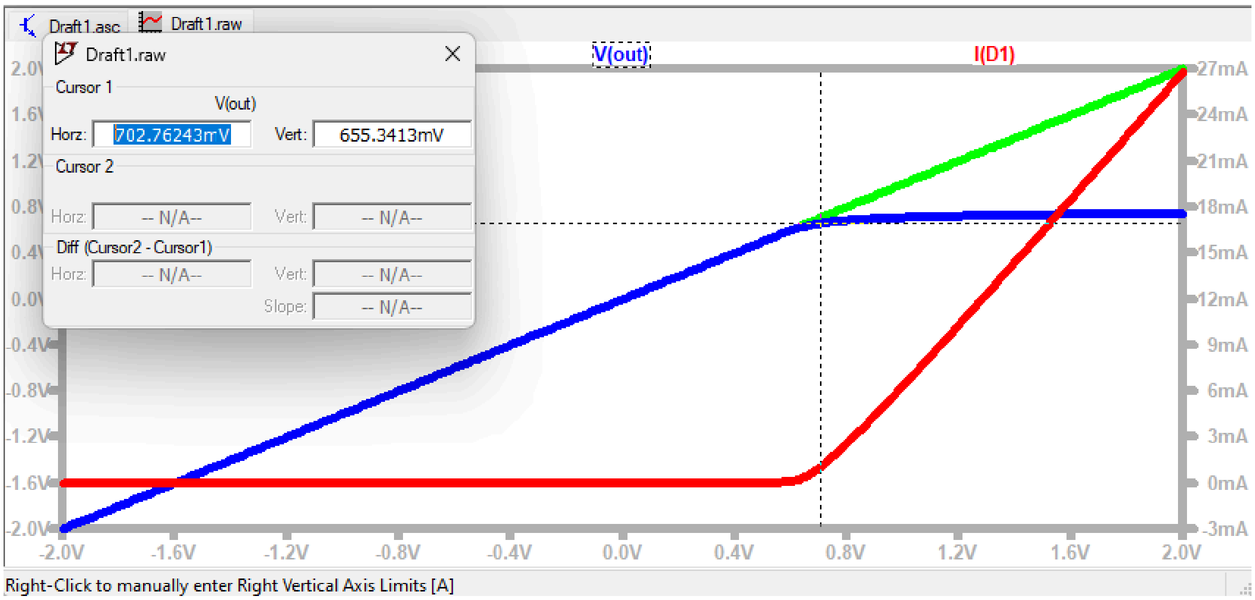
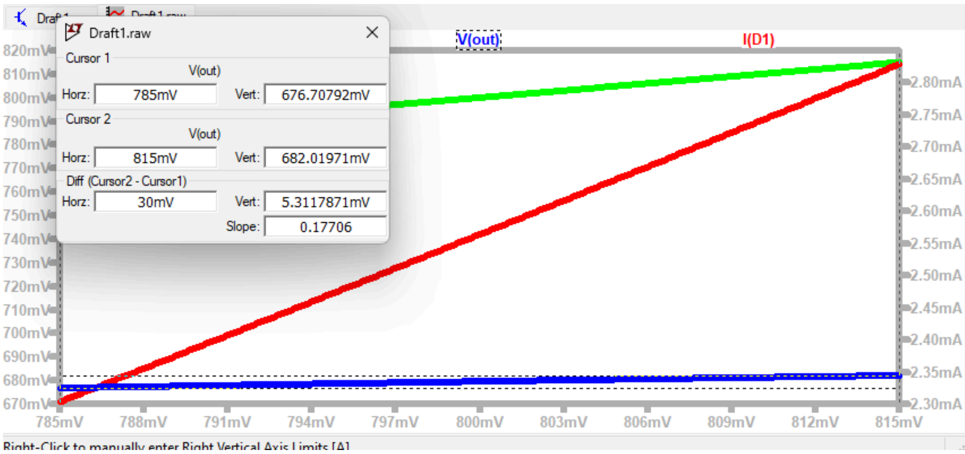
IE lab 2 part2

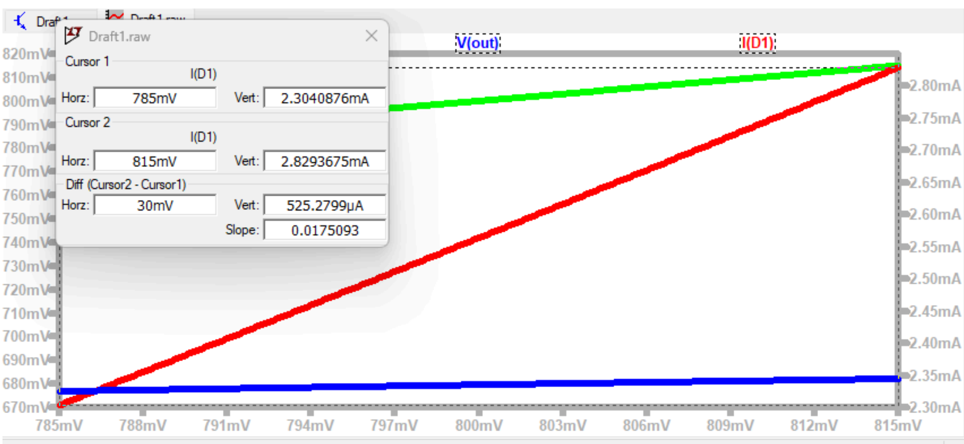
Pre Lab Exercise 1:
1)
In Spice, implement the diode circuit shown below (Figure1). Use the diode component D1N4004 or any other generic diode. Set the source voltage to a 100 Hz sinusoidal wave with a 2 V amplitude.
Plot the V-I characteristics of the diode. You should see a curve similar to the exponential curve we drew in class.
Estimate the turn-on voltage of the diode.



0.7V

2)
In Spice, implement the diode circuit shown below (Figure 2). The circuit includes a DC source and an AC source. Set the DC voltage to 0.8 V. Set the AC sinusoidal voltage to 30 mV peak-to-peak with frequency 100 Hz.
Measure the peak-to-peak AC voltage (VAC) across the diode, and the peak-to-peak ACcurrent (IAC) through the diode.

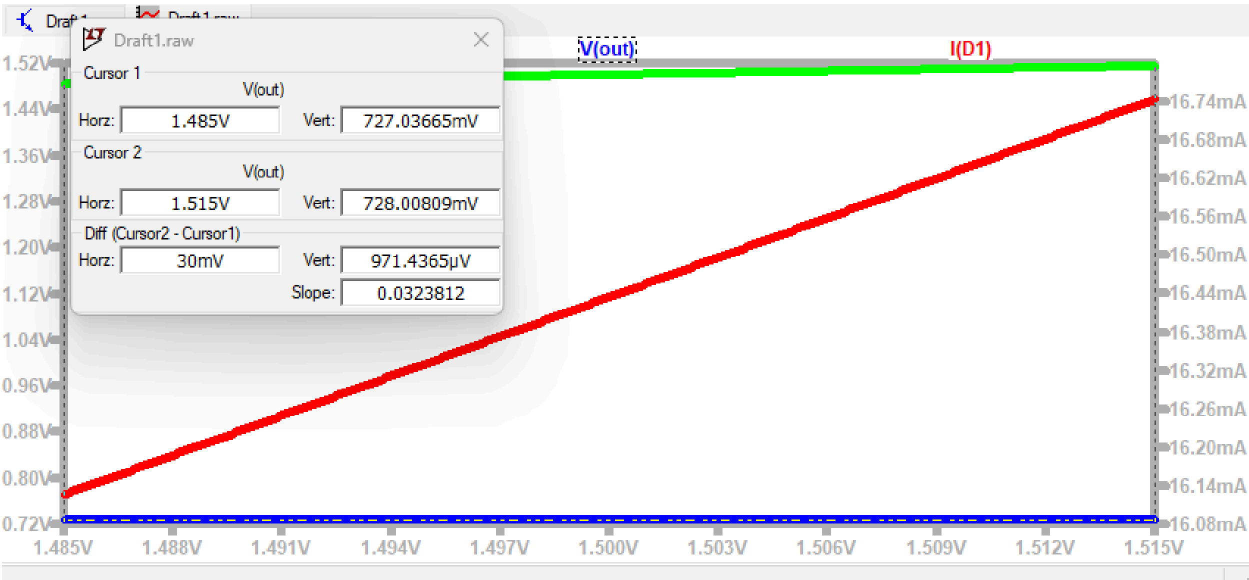


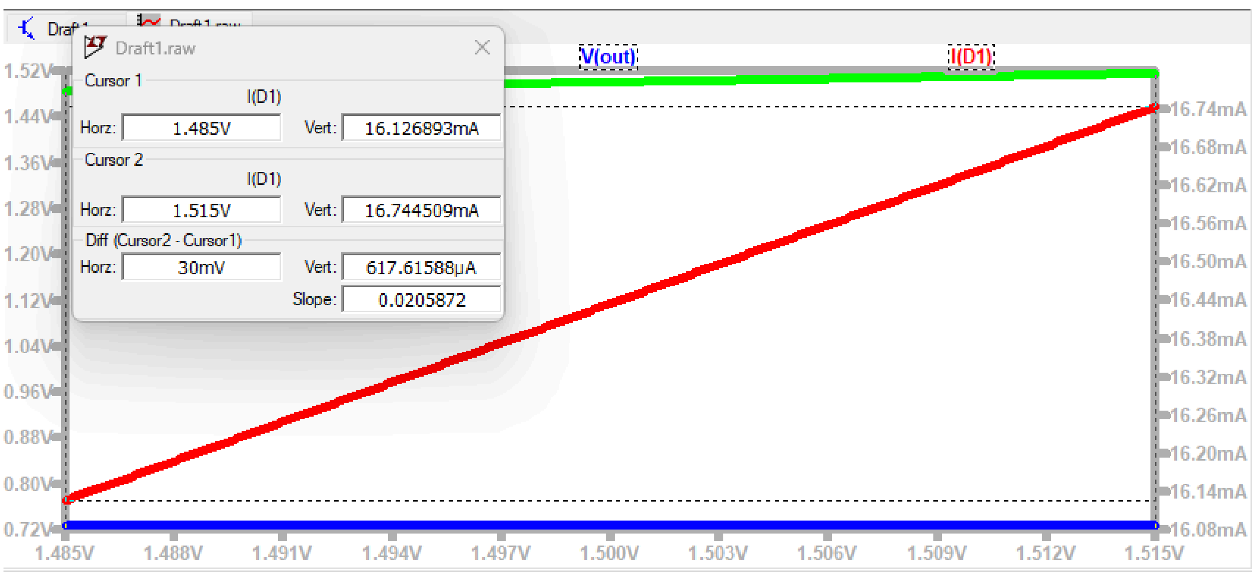


VAC=5.311mV
IAC=0.525mA
Determine the simulated differential diode resistance rD (rD = VAC / IAC). Then determine the theoretical differential diode resistance rD (rD = Vthermal / IDC) at a DC bias of 0.8 V (recall Vthermal = 26 mV). Do simulation and theory agree?

Simulated:
R=VAC/IAC=5.311mV/0.525mA=10.11 Ohms
Theoretical:
IDC=(VDC-VD)/R=.1/47=2.13mA
rD=Vth/IDC=12.22 Ohms

3)
Set the DC voltage to 1.5 V. Measure the peak-to-peak AC voltage (VAC) across the diode, and the peak-to-peak AC current (IAC) through the diode. (Results may be a bit noisy.)
Determine the simulated differential diode resistance rD (rD = VAC / IAC). Then determine the theoretical differential diode resistance rD (rD = Vthermal /IDC) at a DC bias of 1.5 V (recall Vthermal = 26 mV). Do simulation and theory agree?





Simulated:
R=V/I=0.971uV/0.617uA=1.57 Ohms
Theoretical:
IDC=(VDC-VD)/R=.8/47=1.7mA
rD=Vth/IDC=1.53 Ohms

Exercise 1:

1)

Using the 1N4004 Diodes, build the circuit shown below (Figure 6). (Remember ground is necessary, even if it is not shown in the circuit.)

Set the input voltage to a 100 Hz triangle wave with a maximum value of 2 V and a minimum value of –2 V. Measure the voltage across the diode and the voltage across the resistor on separate oscilloscope channels. Use math mode to determine the current through the resistor (which is equal to diode current) and plot diode voltage vs diode current (refer to the introduction for generating xy plots). You may need to adjust the vertical and/or horizontal scale to ‘see’ the plot.

Approximately, based on your plot, what is the turn-on voltage for this diode?

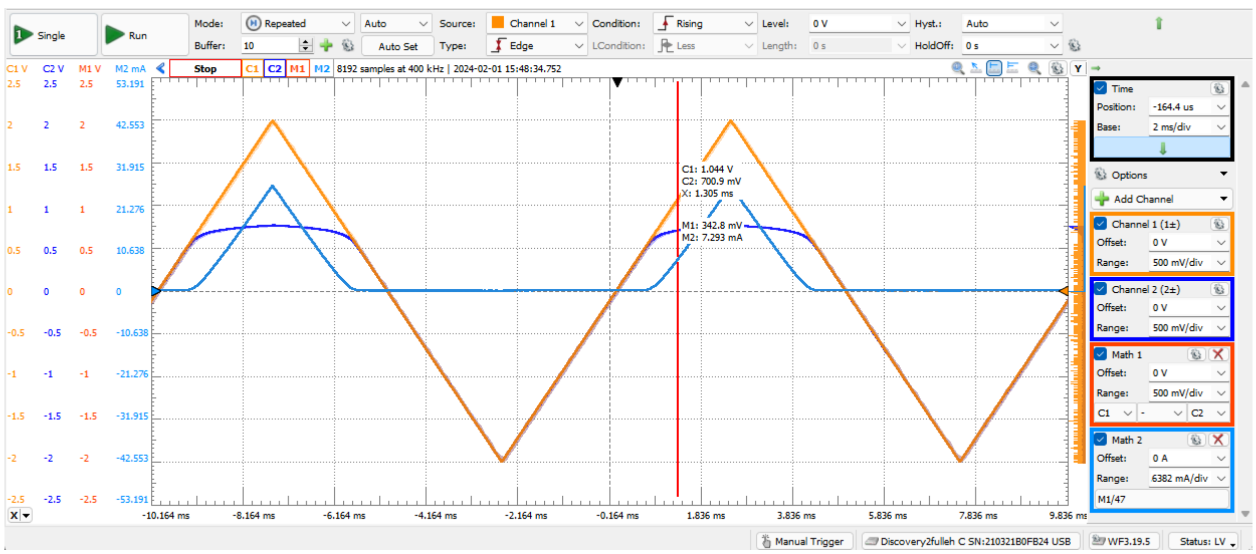
Using triangle waves to more easily see the V-I relationship

C1: Input Voltage

C2: Diode Voltage

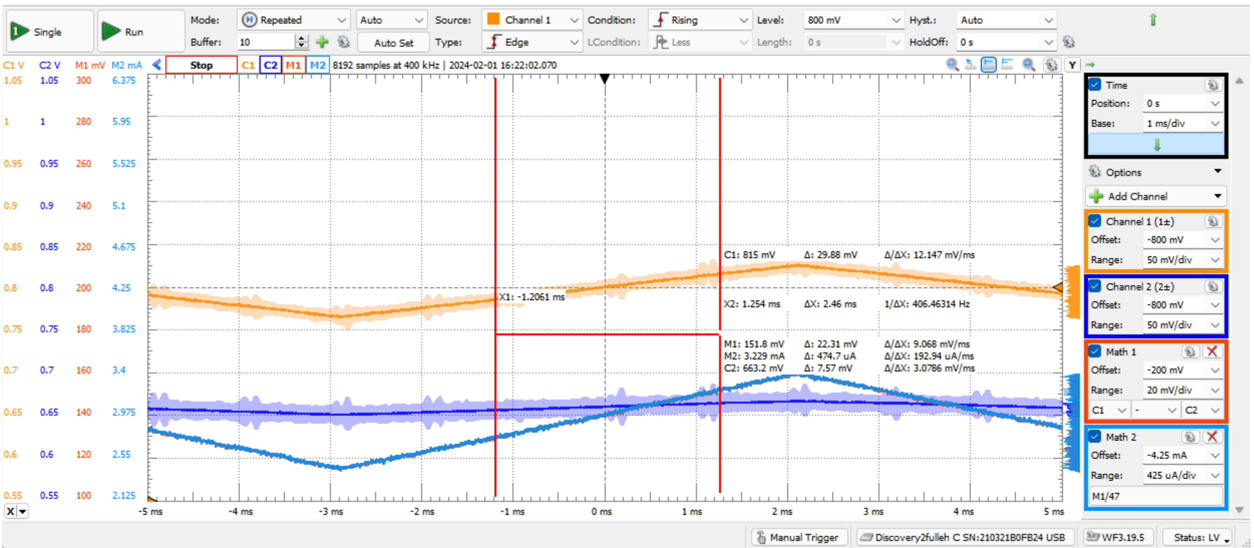
M1: Resistor Voltage

M2: Current (overlapping resistor voltage since they’re directly proportional, but you can see both numbers)



About 0.7V

2)
Set the input voltage to a 100 Hz, 30 mVpp (15 mV amplitude) sinusoidal wave with a 0.8 V DC offset. Identify the DC operating point of the diode (i.e. the DC average voltage and the DC average current). You can use the Measure Tab in the top center to add various voltage measurements. Measure the peak-to-peak AC voltage and peak-to-peak AC current of the sinusoidal components for the diode.
Determine the differential diode resistance (rD = VAC /IAC) associated with the AC component. Draw the small-signal model of the circuit for this source voltage. How does rD compare to an estimate of the slope of the I-V curve (see above, Part 2 of Pre-Lab Exercise 1) at the DC operating point? Is rD consistent with your expectation?

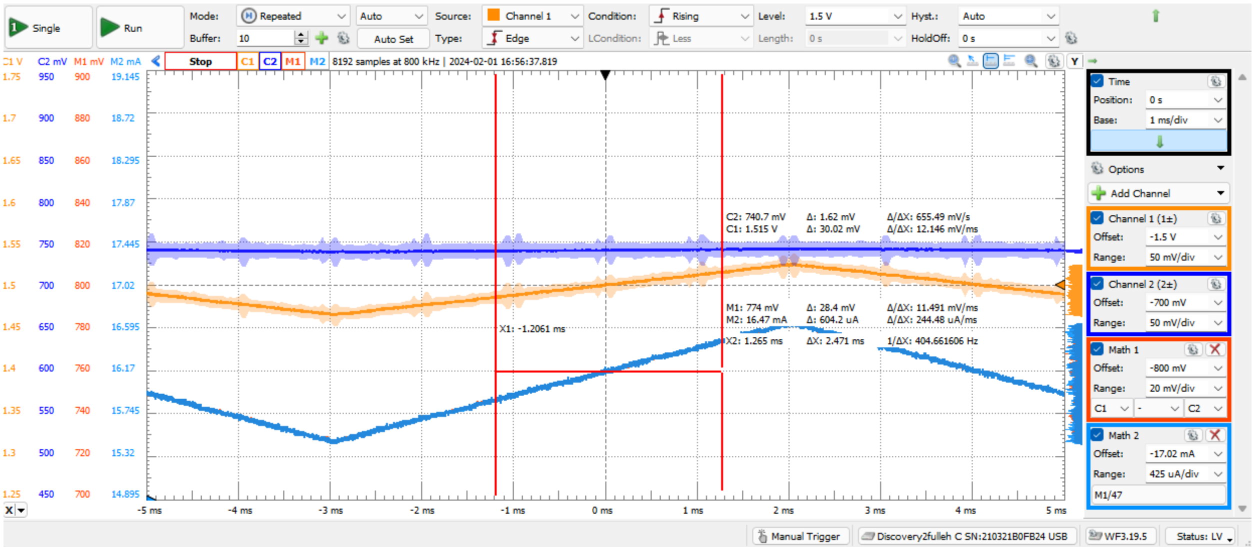


rD=7.57mV / 474.7uA = 15.95 Ohms
It’s close to 12 ohms and is consistent with our expectations.

3)

Change the offset voltage to 1.5 V. Identify the diode's DC operating point (VDC and IDC), and the diode's AC values (VAC and IAC).

Determine the differential diode resistance (rD = VAC /IAC) associated with the AC component. Draw the small-signal model of the circuit for this source voltage. How does rD compare to an estimate of the slope of the I-V curve (measured above, under part 2) at the DC operating point? Is rD consistent with your expectation?



rD=1.62mV / 604.2uA = 2.68 Ohms

It's close to 1.6 ohms and is consistent with our expectations.