California State University Sacramento
Electrical and Computer Science Department

EEE 108L Lab - Section 05
Laboratory Experiment Number 5: Lab Report

<u>Diodes Circuits</u>

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Abstract

For this laboratory experiment we are introduced to a semiconductor device. We are using Diodes and experimenting on the nonlinear characteristics of a small signal diode. For the diode we will be using is 1N914 for the experimental portion of the lab. And for the Pspice simulation portion of the lab we will be using 1N4148.

Part 1: Preliminary Calculations

STEP 1:

Given: ND = 1x10^15 cm^-3, Ni = 1.5 x 10^10

Find the majority carrier (n) and the minority carrier (p)

Pn= Ni^2/ND = (1.5x10^10)^2 / (1x10^15) = 2.25 x 10^5

Given: NA = 1x10^17 cm^-3

Find the majority carrier (p) and the minority carrier (n)

Np= Ni^2/NA = (1.5x10^10)^2 / (1x10^17) = 2.25 x 10^3

V = 0.69V

Is = 2x10^-14

VD	**ID**	**Rf = 1/gd = nVt/Id**
0.4	**9.61x10^-8A**	**268.6kΩ**
0.5	**4.50x10^-6A**	**5.7kΩ**
0.6	**2.11x10^-4A**	**123Ω**
0.7	**1.0x10^-2A**	**2.6Ω**
0.8	**1.73A**	**0.015Ω**

STEP 2: Finding ID1 and ID2 in terms of Vbias and Rbias and R

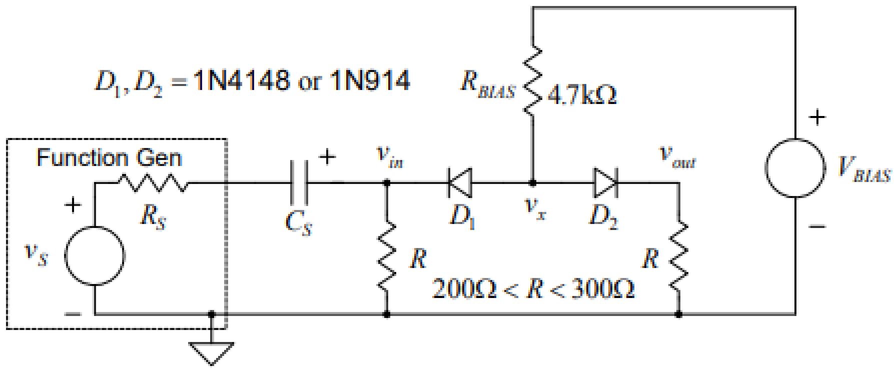


Figure 1.

Given: VD = 0.7V

Vx = ((Vbias/Rbias)+((VD1 +VD2)/R)/ ((1/Rbias)+(2/R)))

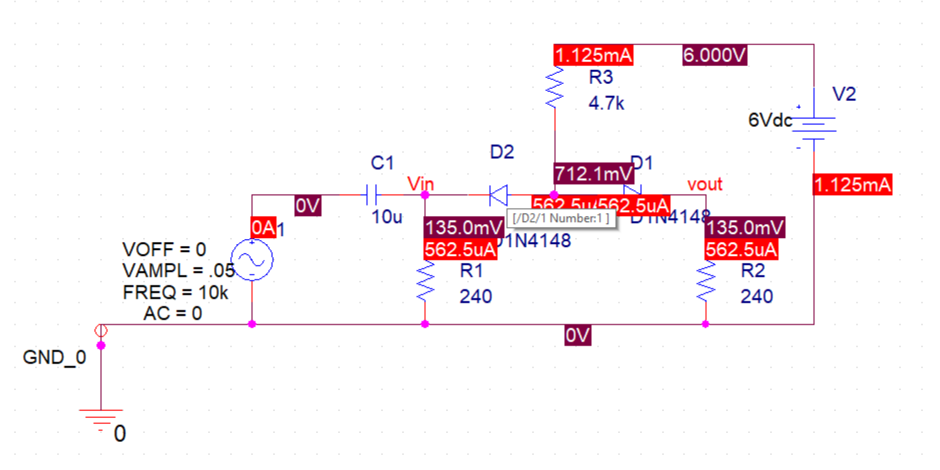
$I_{D1} = I_{D2}$ = (Vx-VD1)/R

=((Vbias/Rbias)+((VD1 +VD2)/R)/ ((R/Rbias)+(2))) - (VD1/R)

STEP 3:

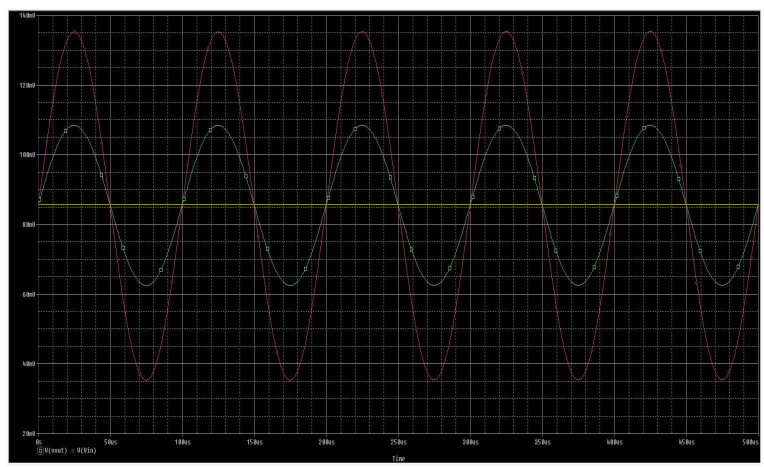
Part 2: Spice Simulations

STEP 4: Construction of Circuit 1 on pspice



STEP 5:

Find the value of rd **6V bias**



a. $V_o/V_i = -134/-102 = 1.314$

$R_d = (240/1.314) - 240 = -57.314/2$

$R_d = -28.66$

Find the value of n

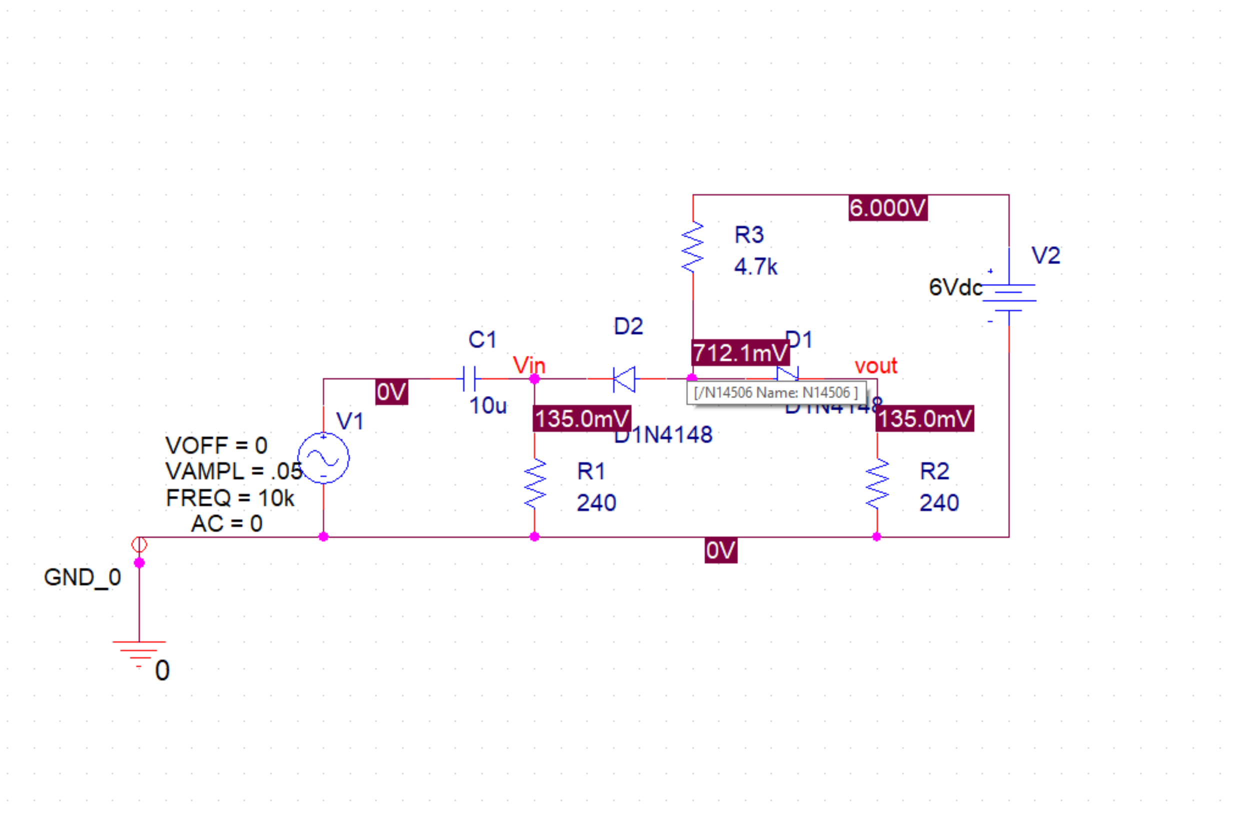
b. $nV_t/I_d = r_d$

$1 \leq n \leq 2$

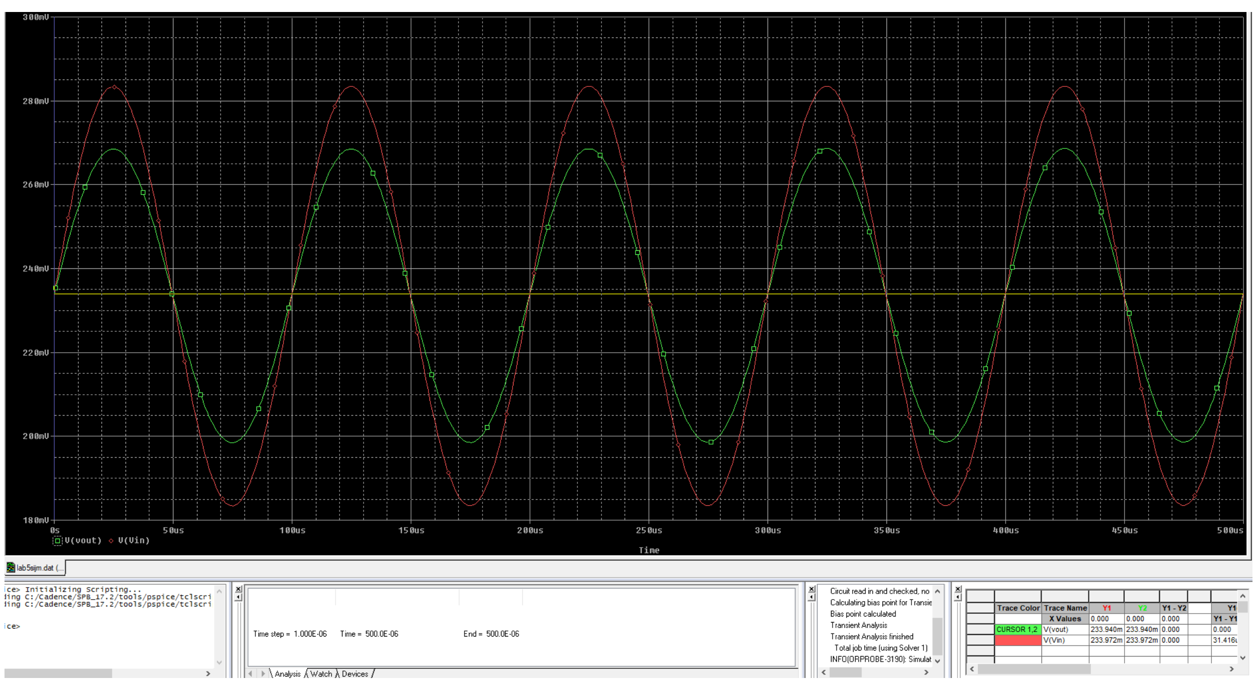
	Trace Color	Trace Name	Y1	Y2	Y1 - Y2
		X Values	49.717u	0.000	49.717u
	CURSOR 1,2	V(vout)	134.907m	135.010m	-102.838u
		V(Vin)	134.907m	135.041m	-134.254u

No, not in reason

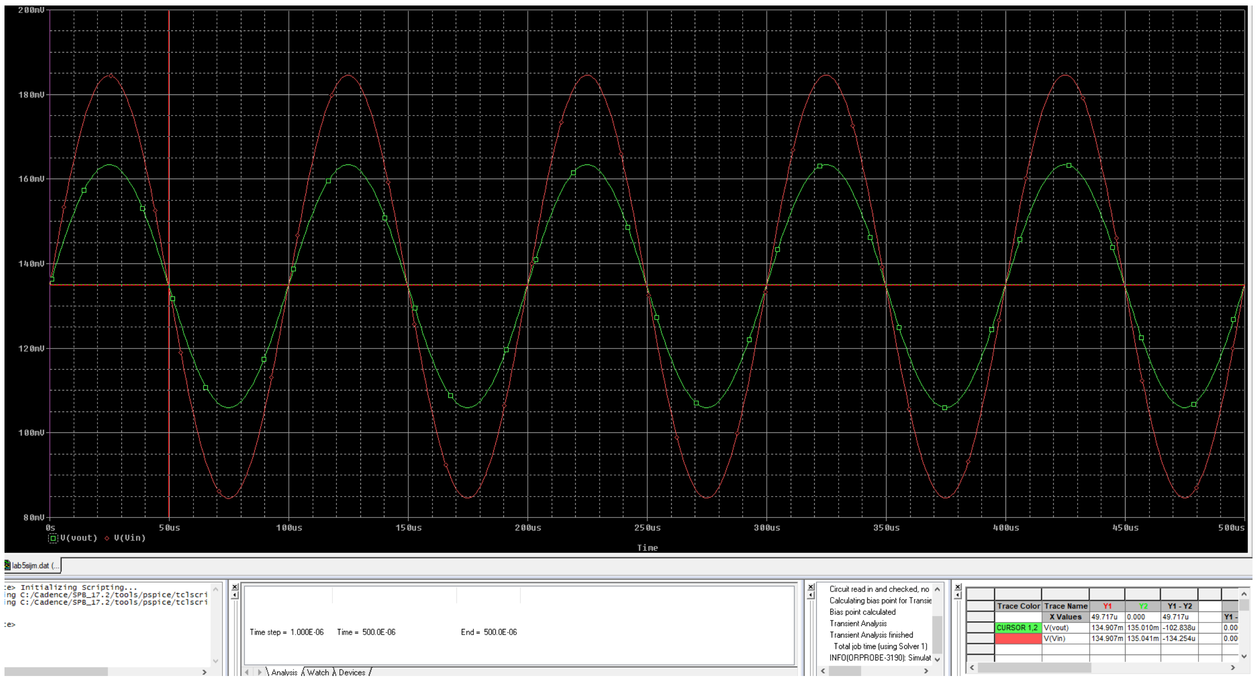
STEP 6:



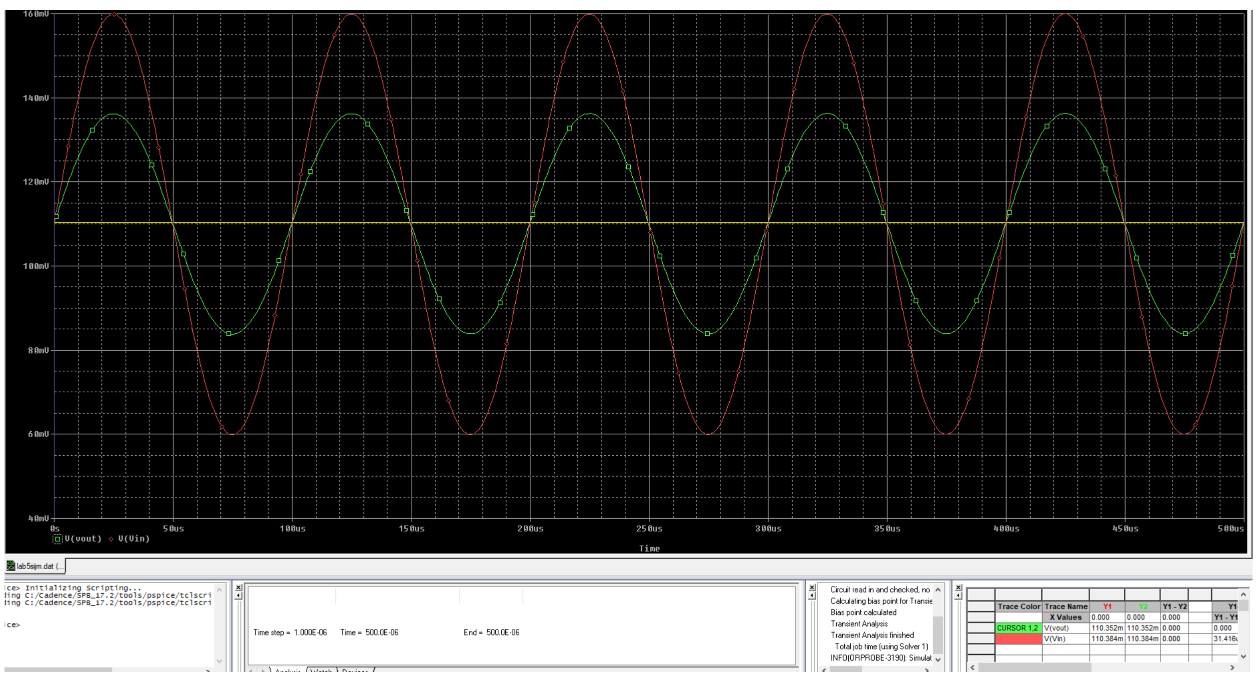
10V Vbias



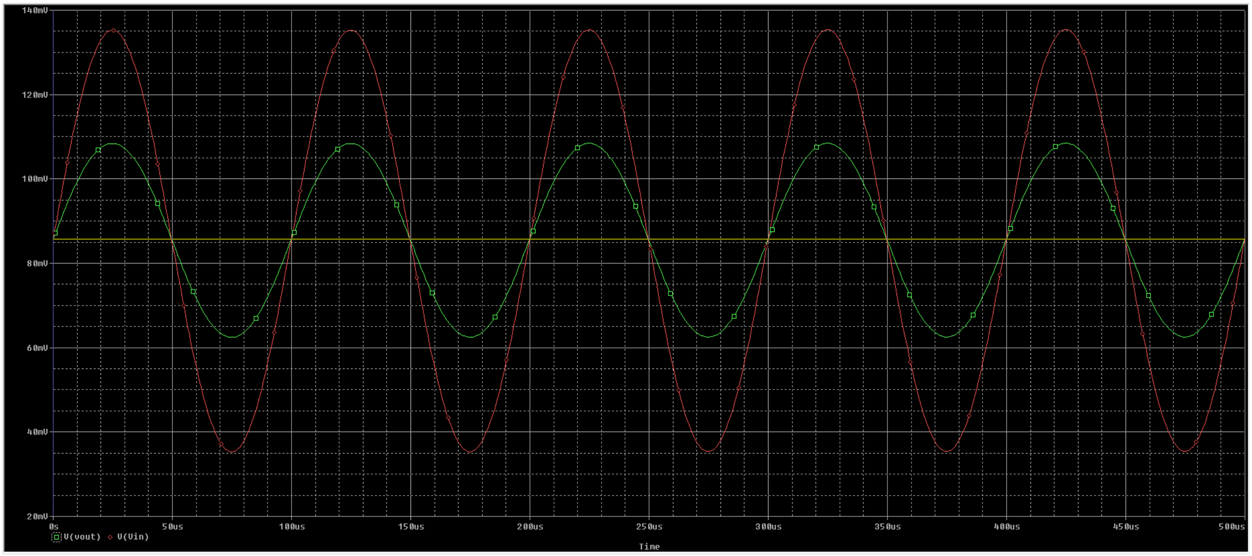
6V Vbias



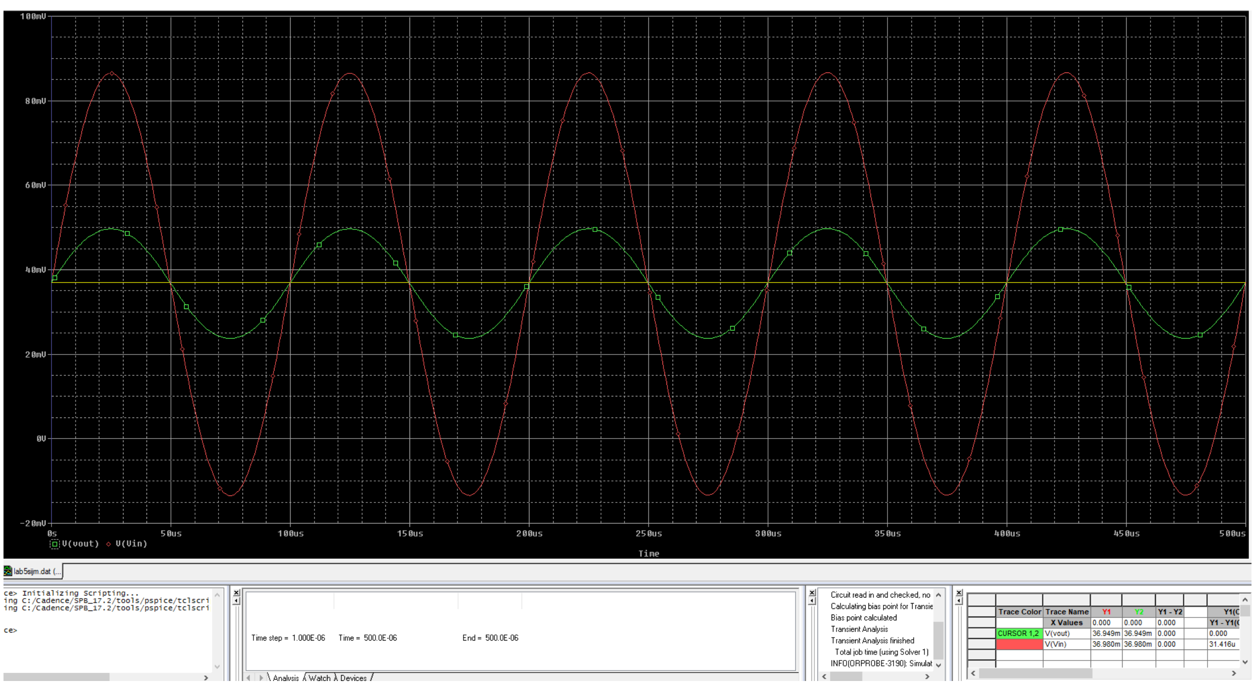
5V Vbias



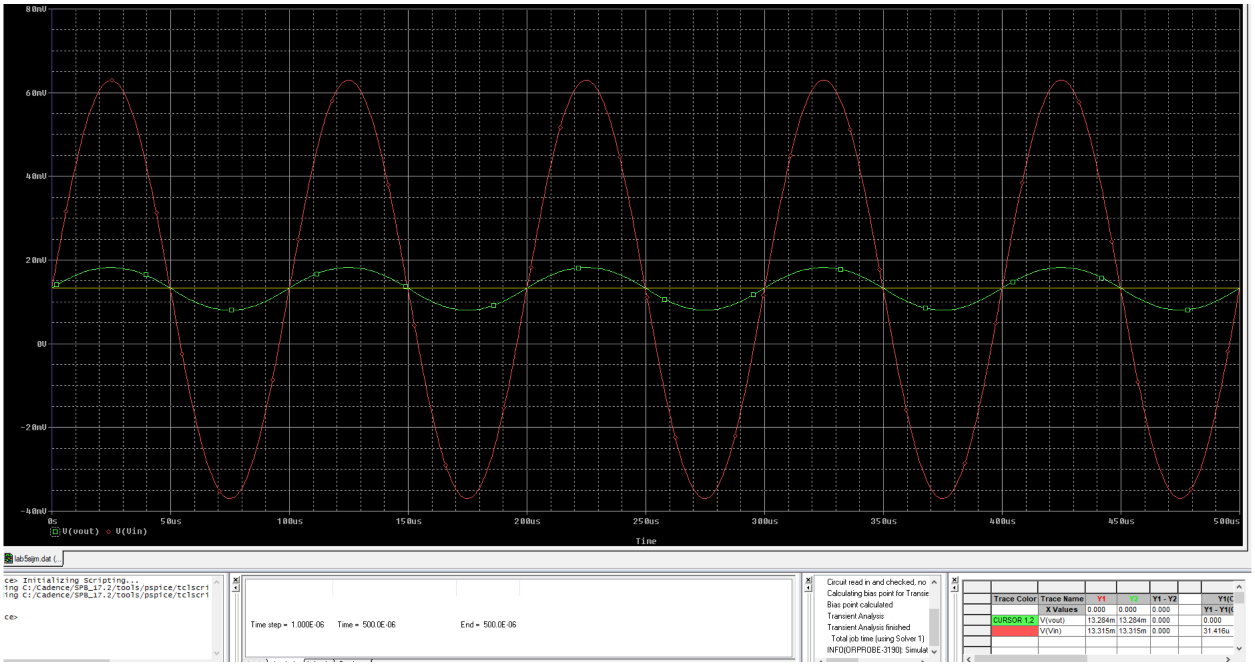
4V Vbias



2V Vbias



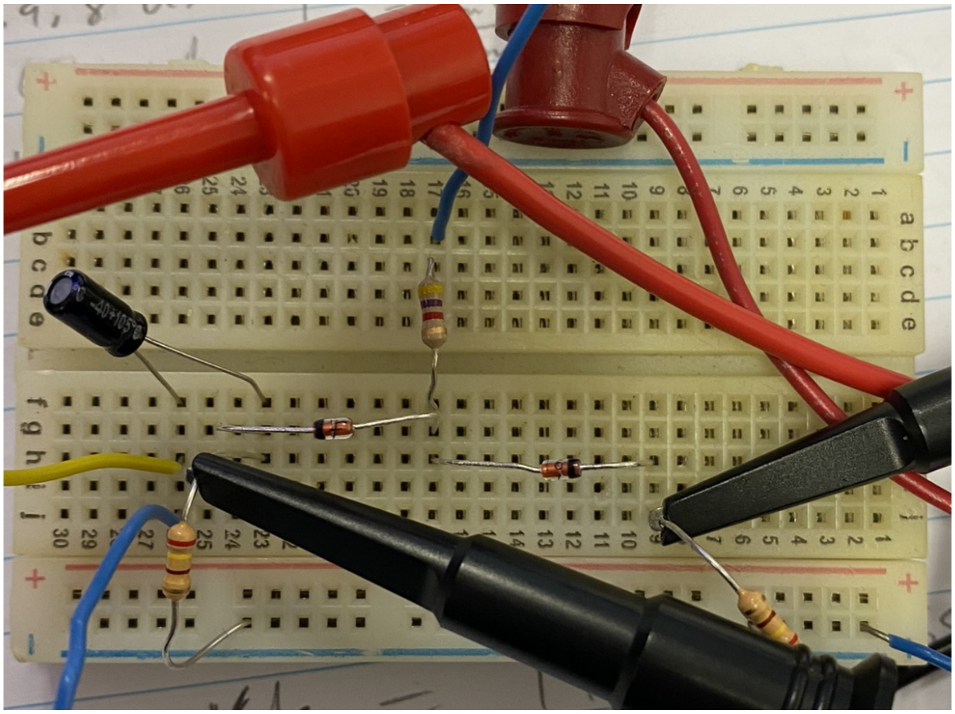
1V Transient Analysis Vbias



Part 3: Laboratory Experiment

Section 1: Circuit Construction and Small-Signal Behavior

STEP 7: Hardware construction of the circuit



Vin = 136.23mV

STEP 8:

How does the AC magnitudes at Vin change as Vbias is changed?

-As the Vbias increases Vin and Vout increases.

Vbias	Vin	Vout	Vo/Vin	rd	V mean
6V	0.160V	0.095	0.59	83.39	0.136
3V	0.166V	0.0646	0.39	187.7	0.0614
2V	0.170V	0.044	0.26	341.5	0.0367
1V	0.174V	0.0206	0.12	880	0.0128

STEP 9: repeat calculations from step 5 with the values found from the experimental portion.

$$I_{d_6} = \frac{.136}{240\Omega} = 0.00057$$

$$r_d = \frac{nV_T}{I_D}$$

$$I_{d_3} = \frac{0.0614}{240} = 0.000256$$

$$\frac{V_o}{V_{in}} = \frac{1}{1+\frac{2\pi A}{K}}$$

$$I_{d_2} = \frac{0.0367}{240} = 0.000153$$

$$I_{d_1} = \frac{0.127}{240} = 0.000053$$

STEP 10: make plot of the Vo/Vin data

Section 2: Large-Signal Behavior

STEP 11:

As seen in the oscilloscope, The lower the Vbias the lower the peak to peak is for the signal.

STEP 12:

12.) $3V = \frac{\Delta Y}{\Delta X} \Rightarrow \frac{69.3\,mV}{194.8\,mV}$

$6V = \frac{\Delta Y}{\Delta X} \Rightarrow \frac{146\,mV}{265.50\,mV}$

STEP 13: find a value of VBIAS for which out v looks like a sine wave.

As seen in the triangle wave, at 6V with 1V peak to peak, we see the first signs of clipping.

CONCLUSION:

ITEM 1: No, because the current increases and the Vd also increases.

ITEM 2: Vo/ Vin = 1/(1+(2(rd)/R))

When rd = rd2 then the small gain = 1,

When rd1/2 = rd2/2 = the gain = ½,

When rd = rd2 = infinity = then the gain = 1/infinity = 0

ITEM 3: As the Vbias increased the clipping is also increased.

ITEM 4: no, as it can not show small signal gain clipping in saturations, also no, because we are operating in a non linear region.

ITEM 5: no, because the small signal level is not the right saturation.

ITEM 6: Yes, but it was easier to solve and put resistors in series to find the bias currents.