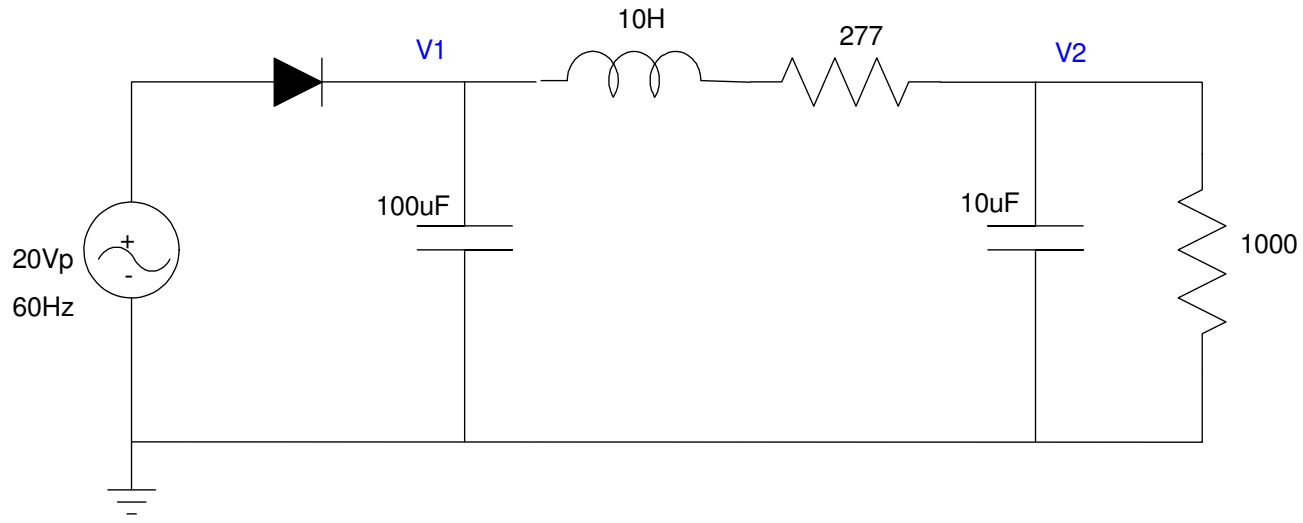
ECE 320 - Homework #4

AC to DC Converters, Max/Min Circuits, Clipper Circuits. Due Monday, Feb 4th, 2019

AC to DC Converters

1) Determine the voltage at V1 and V2 (both DC and AC).



V1:

Vp = 19.3V

$$I \approx \frac{19.3V}{1000\Omega+277\Omega} = 15.1mA$$

$$I = C\,\frac{dV}{dt}$$

$$15.1mA = 100\mu F \cdot \frac{dV}{1/60s}$$

$$dV = 2.5189V$$

DC Voltage: $V_{1(DC)} = 19.3 - \frac{1}{2}dV = 18.4V$

AC Voltage: $V_{1(AC)} = 2.5189V_{pp}$

V2: (DC)

$$V_{2(DC)} = \left(\frac{1000}{1000+277}\right)18.4V$$

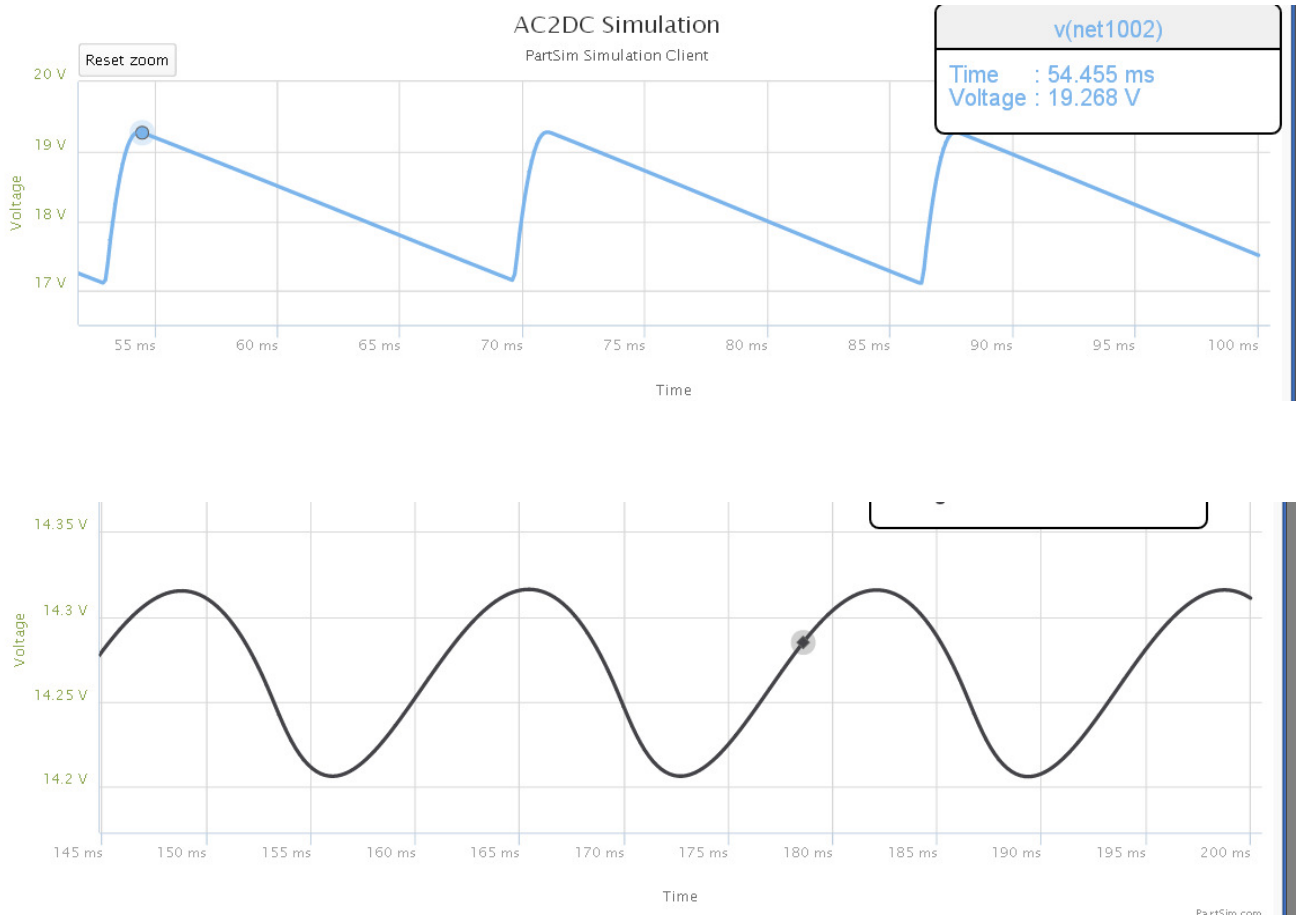
$$V_{2(DC)} = 14.4V$$

V2(AC)

$$V_{2(AC)} = \left(\frac{(65.6-j247.6)}{(65.6-j247.6)+(277+j3770)}\right) \cdot 2.51V_{pp}$$

$$V_{2(AC)} = 0.182V_{pp}$$

2) Simulate this circuit using PartSim (or similar program) to verify your answers for problem 1



3) Lab: Build this circuit in lab and compare your measured values to calculated and simulated values.

	V1		V2	
	DC	AC	DC	AC
Calculated	18.4 V	2.51 Vpp	14.4 V	0.182 Vpp
Simulated	18.204 V	2.149 Vpp	14.261 V	0.110 Vpp
Measured (lab)				

4) Calculate the value of the two capacitors so that

- V1 = 1Vpp
- V2 = 0.2Vpp

V1:

$$V_{1(DC)} = 19.3V - \frac{1}{2} \cdot 1V_{pp} = 18.8V$$

$$I = \frac{18.8V}{1277\Omega} = 14.7mA$$

$$I = C\,\frac{dV}{dt}$$

$$14.7mA = C\,\frac{1V_{pp}}{1/60s}$$

$$C_1 = 245\mu F$$

V2: Assuming C2 = 0

$$V_{2pp} = \left(\frac{1000}{1000+(277+j3770)}\right) 1V_{pp}$$

$$V_{2pp} = 0.251V_{pp}$$

To reduce to 0.2Vpp, the resistor needs to be 20% smaller

$$R = \left(\frac{0.2V_{pp}}{0.251V_{pp}}\right) 1000\Omega = 796\Omega$$

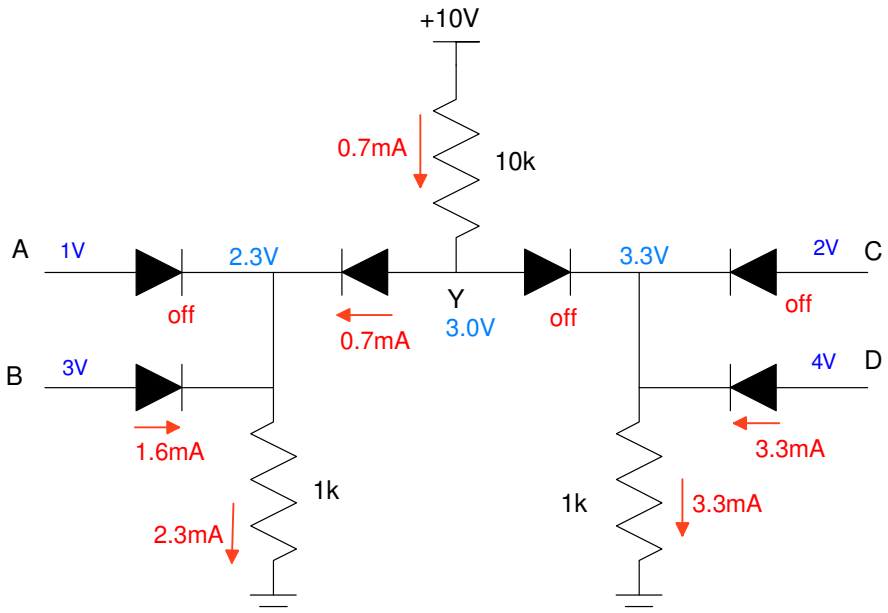
Pick C2 to be 796 Ohms

$$\frac{1}{j\omega C_2} = -j796\Omega$$

$$C_2 = 3.33\mu F$$

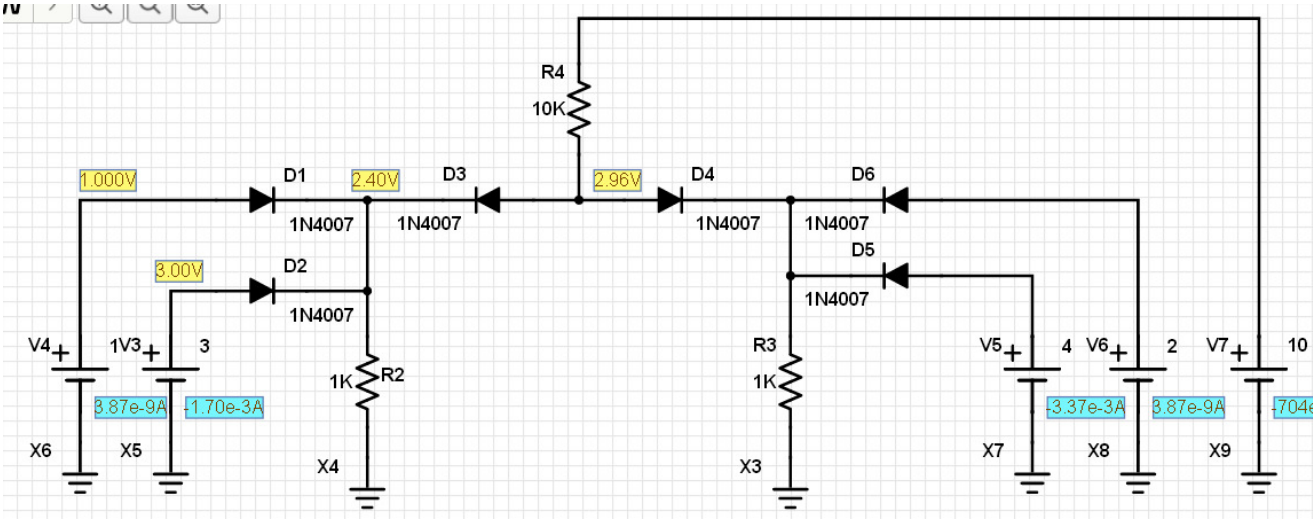
Max/Min:

5) Determine the voltages and currents for the following max/min circuit. What function does this circuit implement? Y = f(A, B, C, D)



Problem 5-6

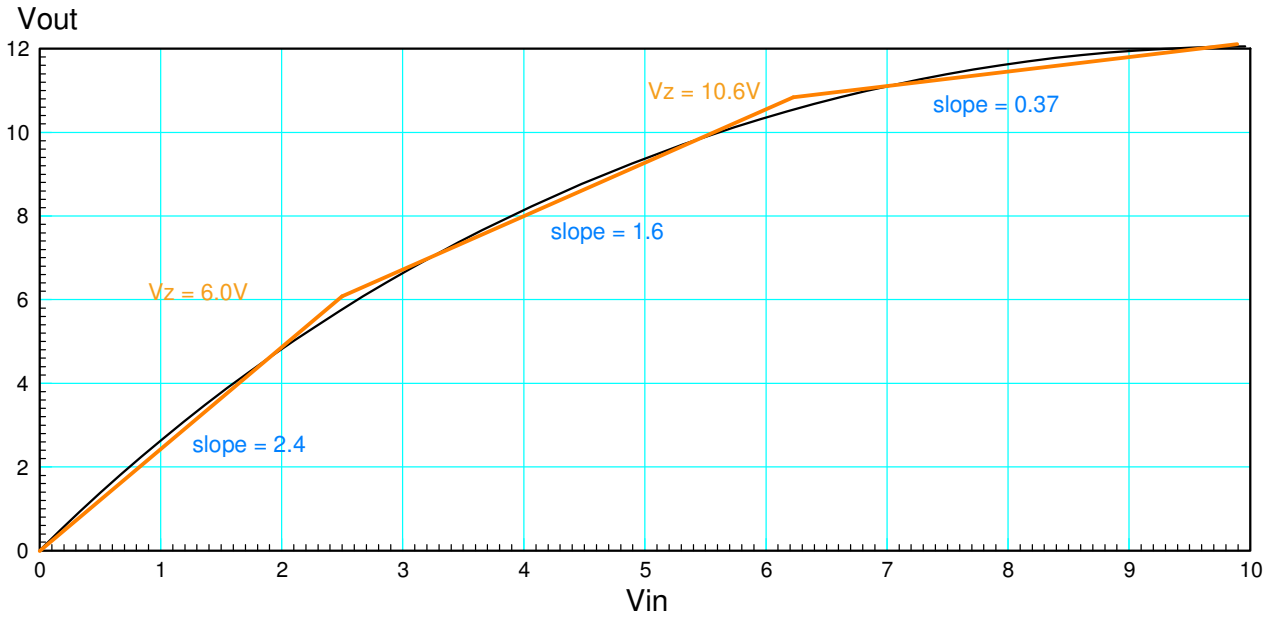
6) Check your results in PartSim (or similar program)



Clipper Circuits:

7) Design a circuit to approximate the following function subject to the following requirements:

- Input: 0 .. 10V, capable of 100mA
- Output: 100k resistor
- Relationship: Graph below, +/- 200mV



Prob lem 7 - 8

Op-Amp:

$$Gain = 2.4 = 1 + \frac{R_1}{R_2}$$

1st Zener

Vz = 6.0V

$$Slope = 1.6 = 2.4\left(\frac{R_3}{R_3 + 1k}\right)$$

$$R_3 = 2.0k$$

2nd Zener

Vz = 10.6V

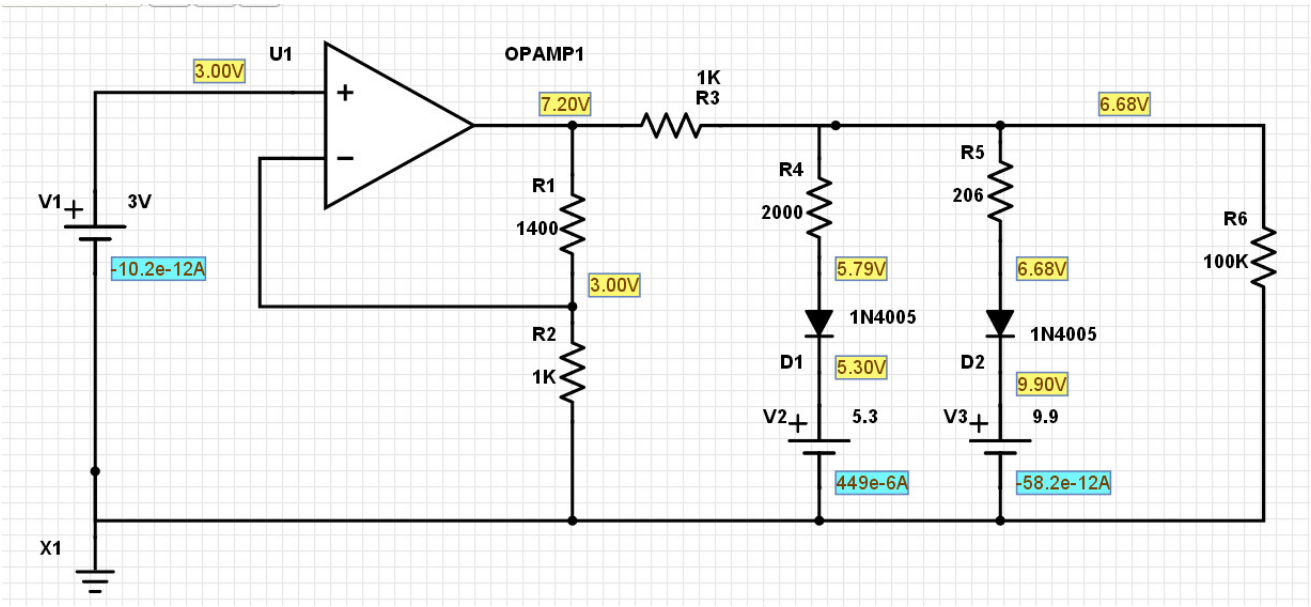
$$Slope = 0.378 = 2.4\left(\frac{R_{34}}{R_{34} + 1k}\right)$$

$$R_{34} = 187\Omega = R_3 \,||\, R_4$$

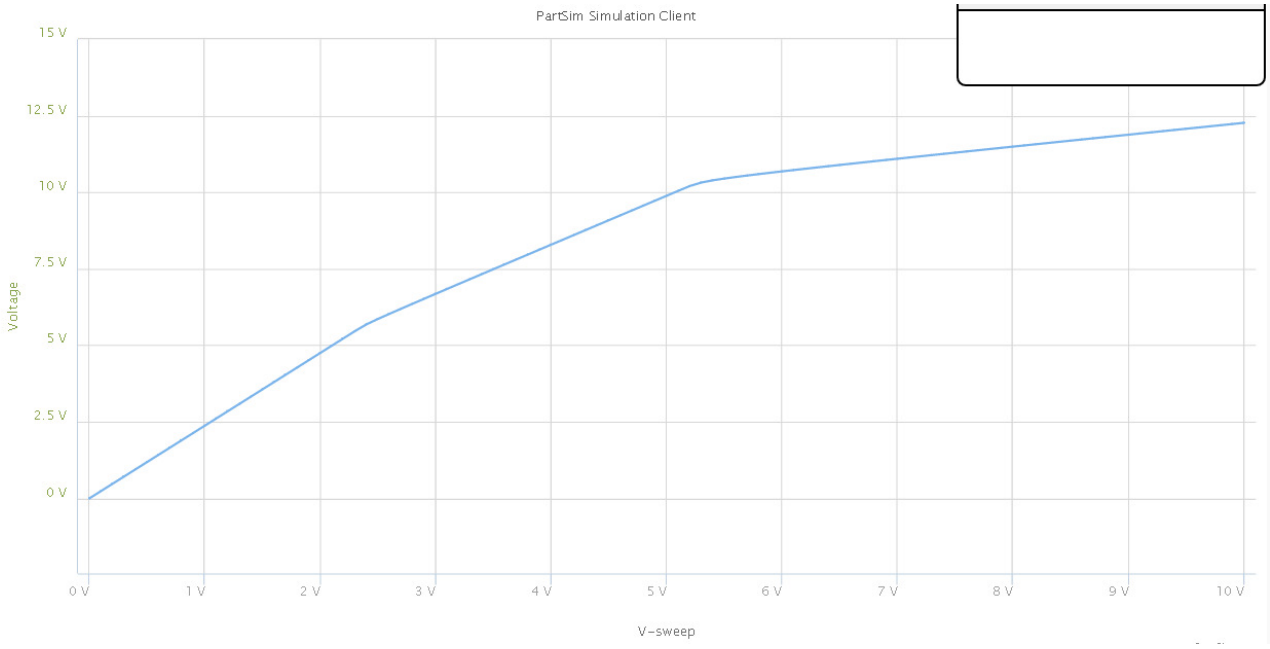
$$R_4 = 206\Omega$$

Gain = 2.4

R1 = 1k, R2 = 1.4



8) Check your design in PartSim



9) Design a circuit which meets the following requirements:

- Input: -10 .. +10V, capable of 100mA
- Output: 1k resistor
- Relationship:

$$V_o = \begin{cases} +5V & V_{in} > 5V \\ V_{in} & -5 < V_{in} < 5 \\ -5V & V_{in} < -5V \end{cases}$$