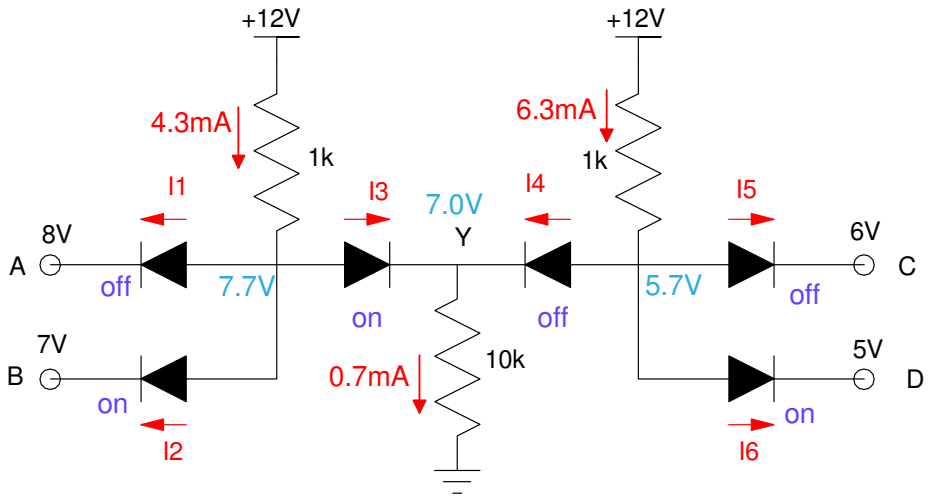
ECE 320 - Homework #4

Max/Min Circuits, Clipper Circuits, Transistor Theory. Due Monday, September 21st

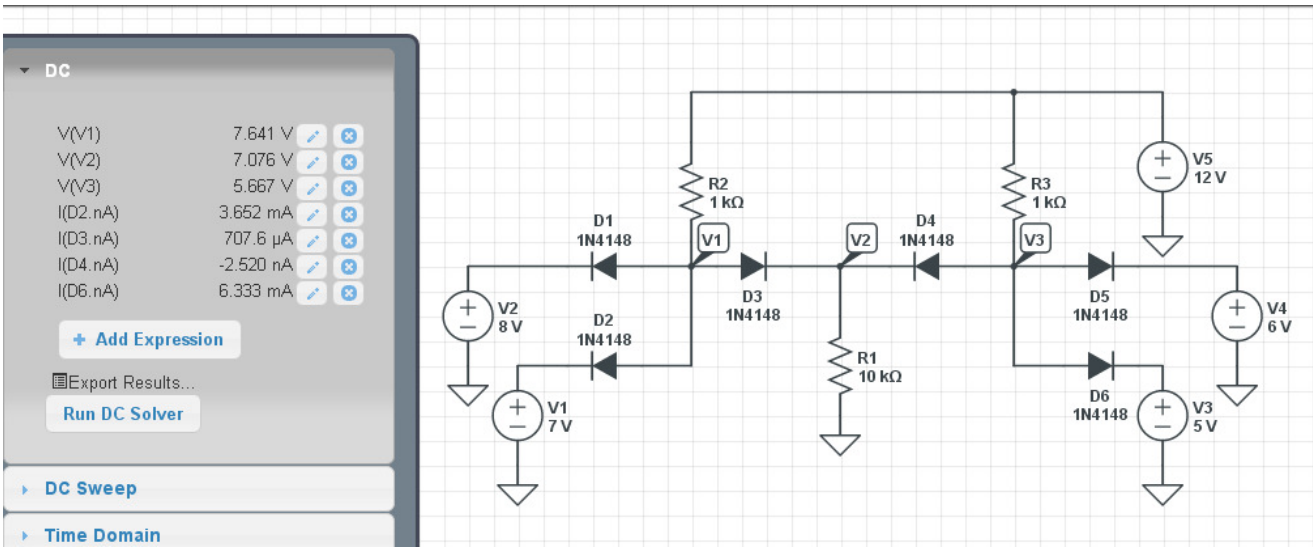
Max/Min:

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



	V1	V2	V3	I2	I3	I6
ideal diode	7.70 V	7.00 V	5.70 V	3.60 mA	0.70 mA	6.30 mA
circuitlab	7.641 V	7.076 V	5.667 V	3.652 mA	0.7076 mA	6.333 mA

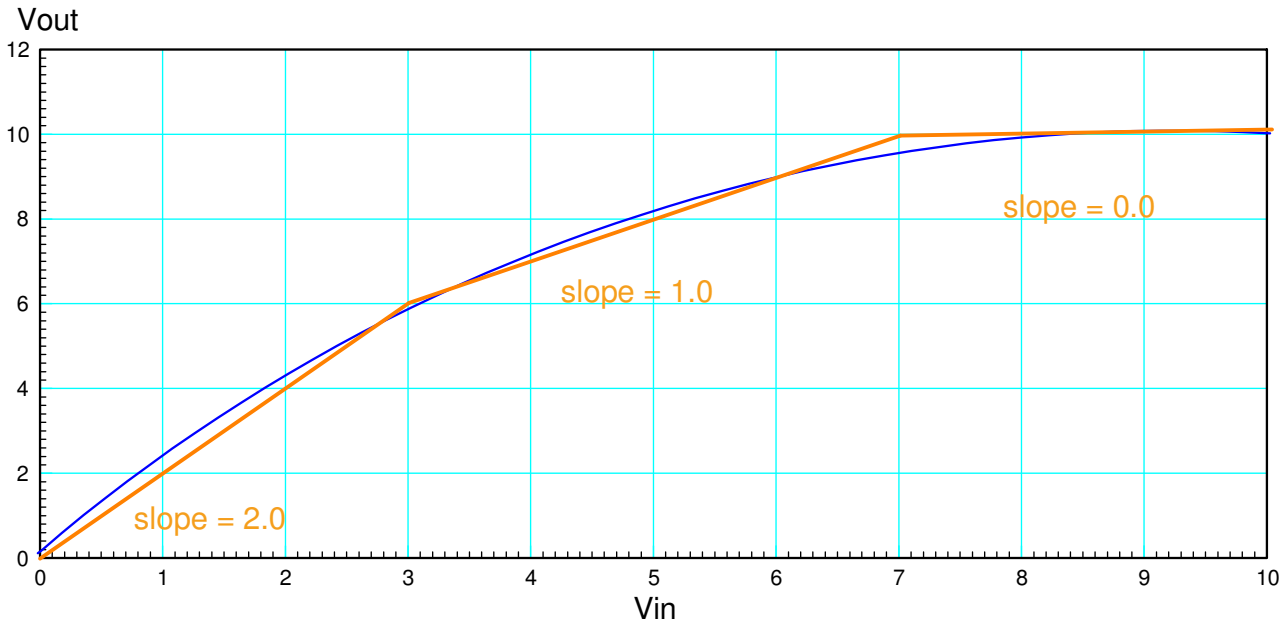
2) Check your results in CircuitLab (or similar program)



Clipper Circuits:

3) 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



Slope = 2.0

$$gain = 1 + \frac{R_0}{1k} = 2.0$$

$$R_0 = 1k\Omega$$

Slope = 1.0

$$V_z = 6.00V$$

$$gain = 1.0 = \left(\frac{R_1}{R_1 + 1k}\right)(2.0)$$

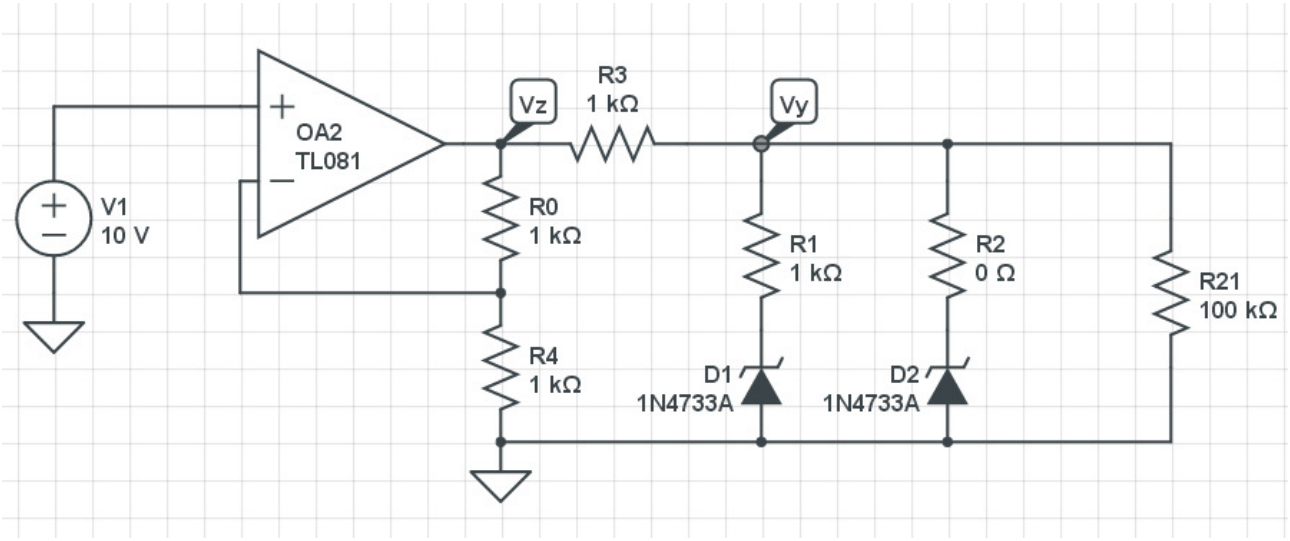
$$R_1 = 1k\Omega$$

Slope = 0.0

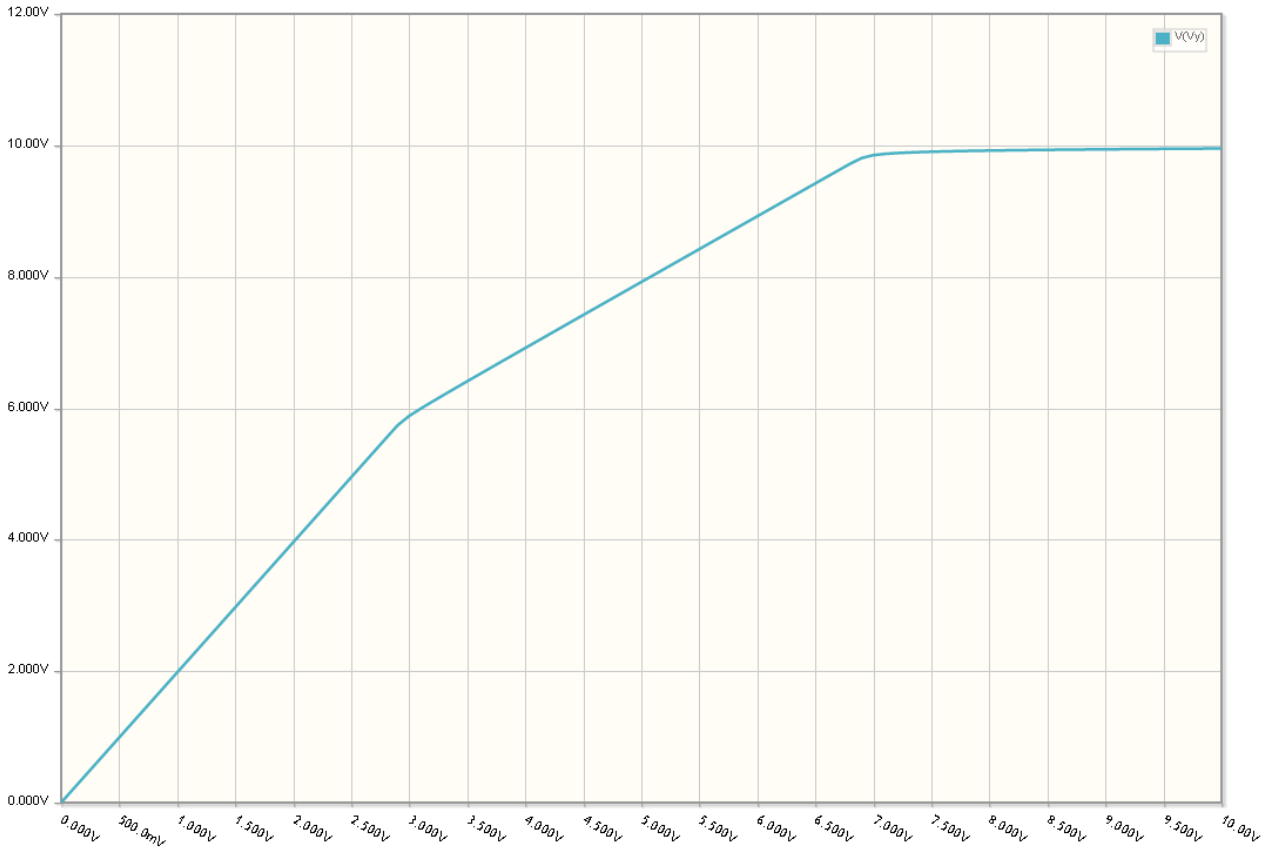
$$V_z = 10.0V$$

$$R_2 = 0\Omega$$

4) Check your design in CircuitLab



zener diodes modified for Vz = 6.0V and Vz = 10.0V

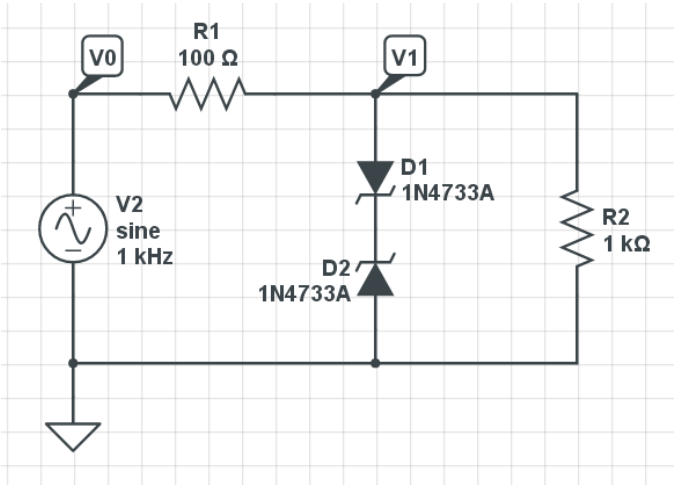


V2 vs. Vin for the clipper circuit

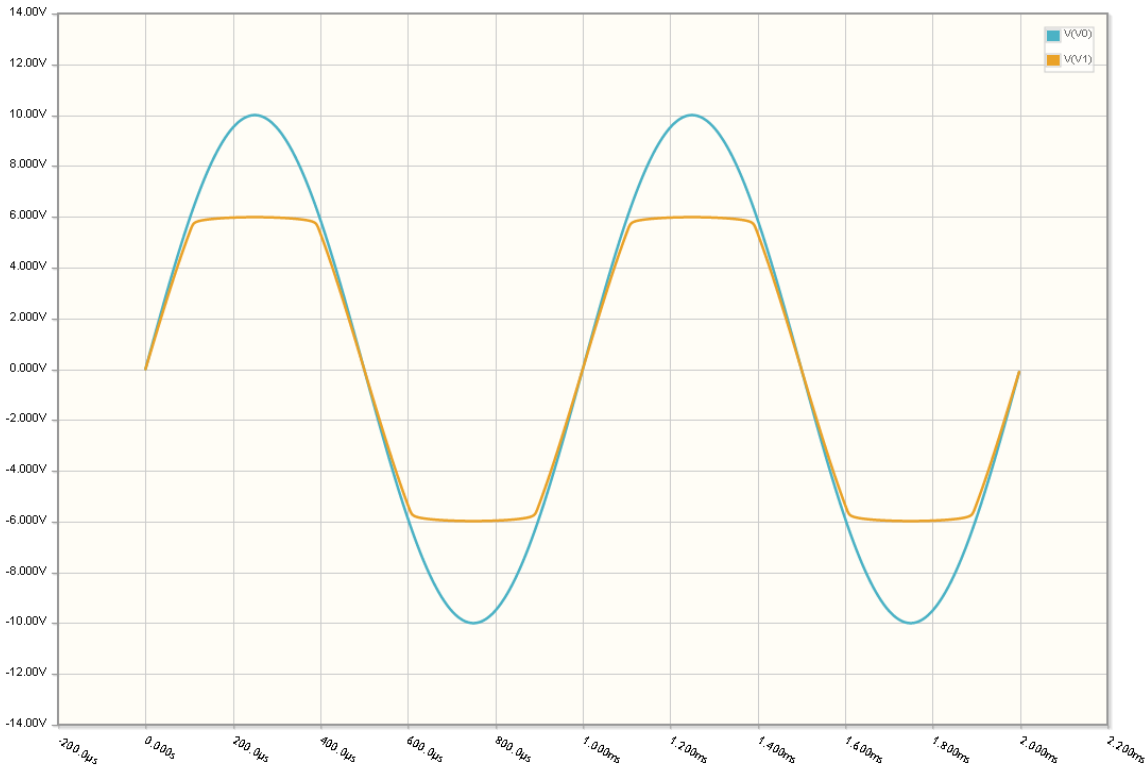
5) Design a circuit which meets the following requirements:

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

$$V_{out} = \begin{cases} +6V & V_{in} > +6V \\ V_{in} & -6V < V_{in} < +6V \\ -6V & V_{in} < -6V \end{cases}$$



Vz modified for Vz = 5.3V



V1 (orange) clips at +6V and -6V

Transistors

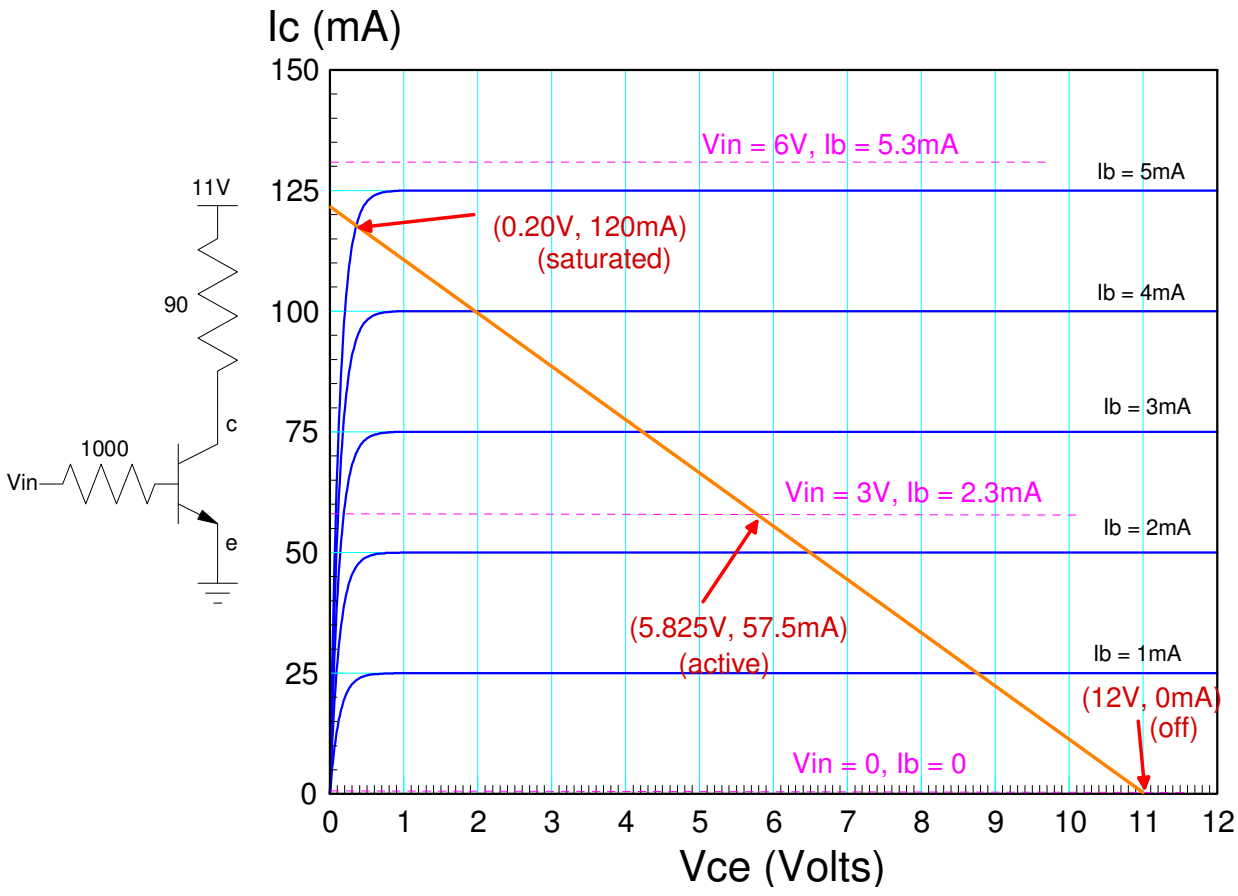
6) Determine the current gain, β, for the transistor show below. Also label the off, active, and saturated regions.

when Ib = 5mA, Ic = 125mA

$$\beta = \frac{125mA}{5mA} = 25$$

7) Draw the load-line and determine the Q-point for

- Vin = 0V
- Vin = 3V
- Vin = 6V



Lab: Please include a photo of your circuit to receive credit for problems 8-10

8-10) Build the following circuit with your electronics kit.

- Measure Vce and Ic for 1k < Rb < infinity.
- Determine the operating point for each conidition and the current gain for your 3904 transistor
- Draw the load line on the graph below and mark each point you measured

Rb	Ib	Vce	Ic	Current Gain (Ic/Ib)	Operating Region (off / active / saturated)
1k br - bl - re	4.25mA	0.01V	4.99 mA	1.174	saturated
10k br - bl - or	428uA	0.06 V	4.94 mA	11.54	saturated
100k br - bl - ye	43.30 uA	3.11 V	1.89 mA	**43.65**	active
1M br - bl - gr	4.410 uA	4.79 V	0.21 mA	**47.62**	active
infinity	0 uA	4.98 V	0 mA	n/a	off