ECE 320 - Homework #6

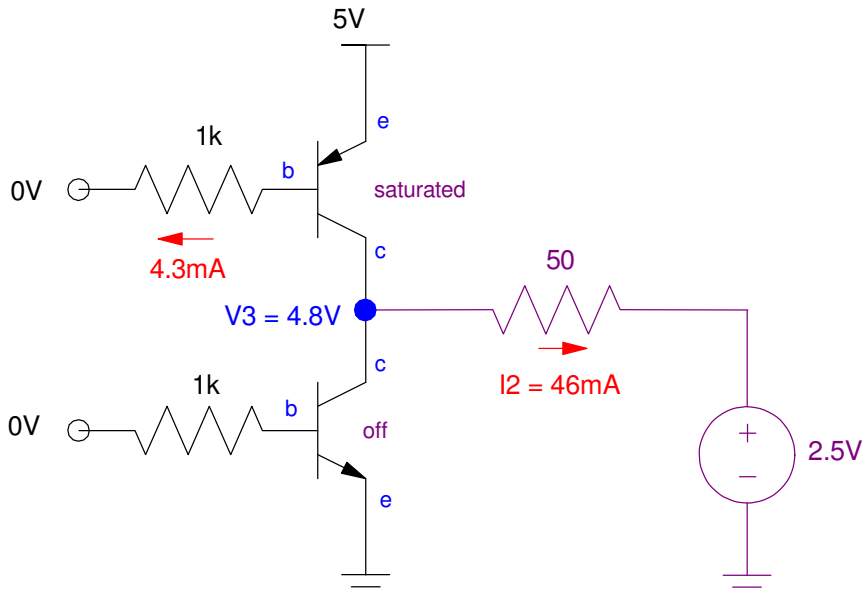
H-Bridge, DC to DC Converters

H-Bridges:

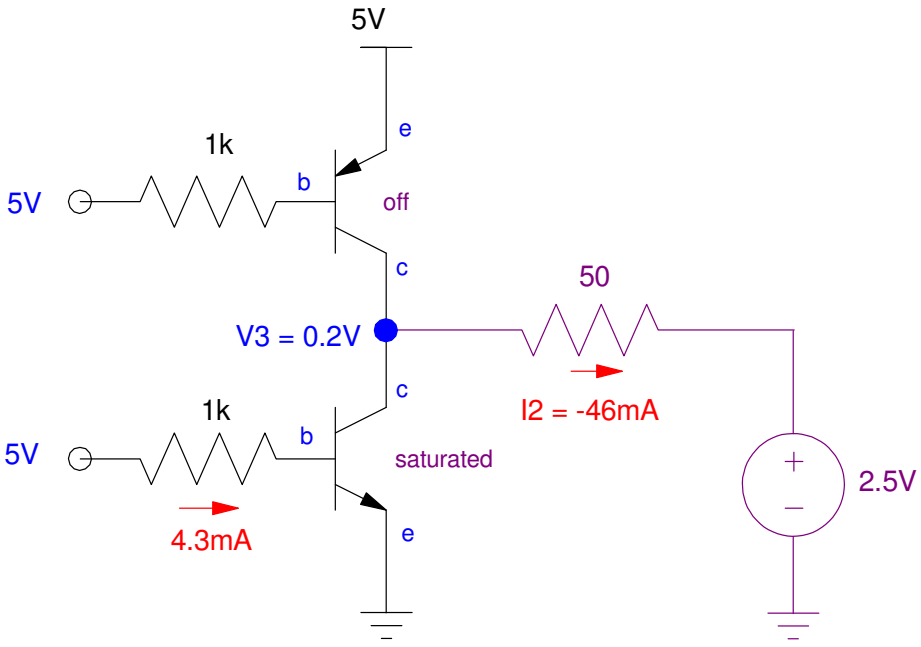
1) Determine the voltages and currents for the following 1/2 H-bridge for

- V1 = 0V, V2 = 0V
- V1 = 5V, V2 = 5V
- V1 = 5V, V2 = 0V

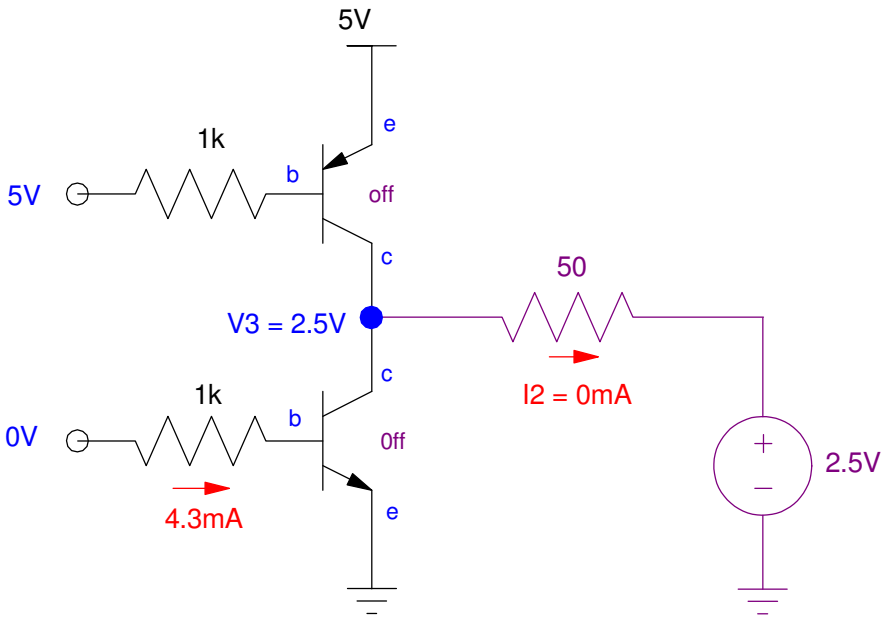
Assume 3904/3906 transistors



0V : 0V results in V2 = 4.8V

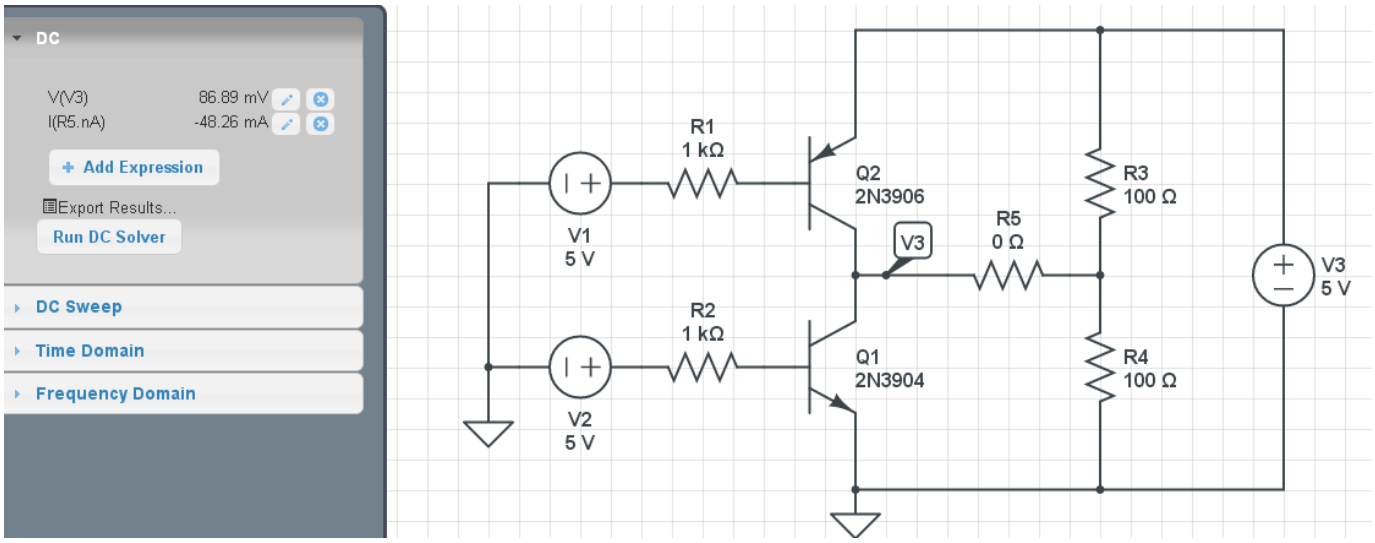


5V : 5V results in 0.2V



Voltages for 5V : 0V input

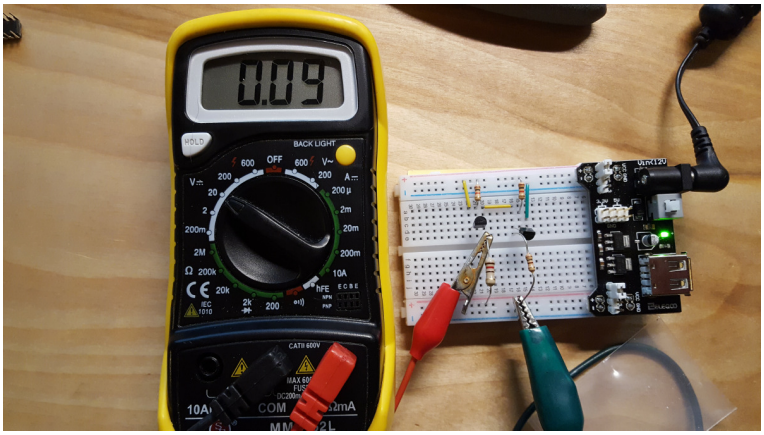
2) Check your results (votlages and currents) in CircuitLab

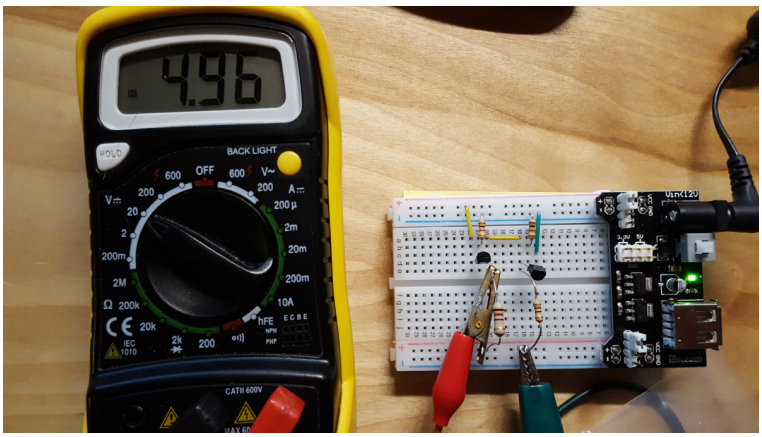


		Calculated	Simulated	Measured
V1 = 5V V2 = 5V	V3	0.20V	86.89mV	
	I3	-46.0mA	-48.26mA	
V1 = 0V V2 = 0V	V3	4.80V	4.884V	
	I3	+46.0mA	+46.87mA	
V1 = 5V V2 = 0V	V3	2.50V	2.500V	
	I3	0.0mA	0.0mA	

3) Lab: Build this circuit and measure the voltages and currents. (note: it's OK to compute the currents from the measured votlages).

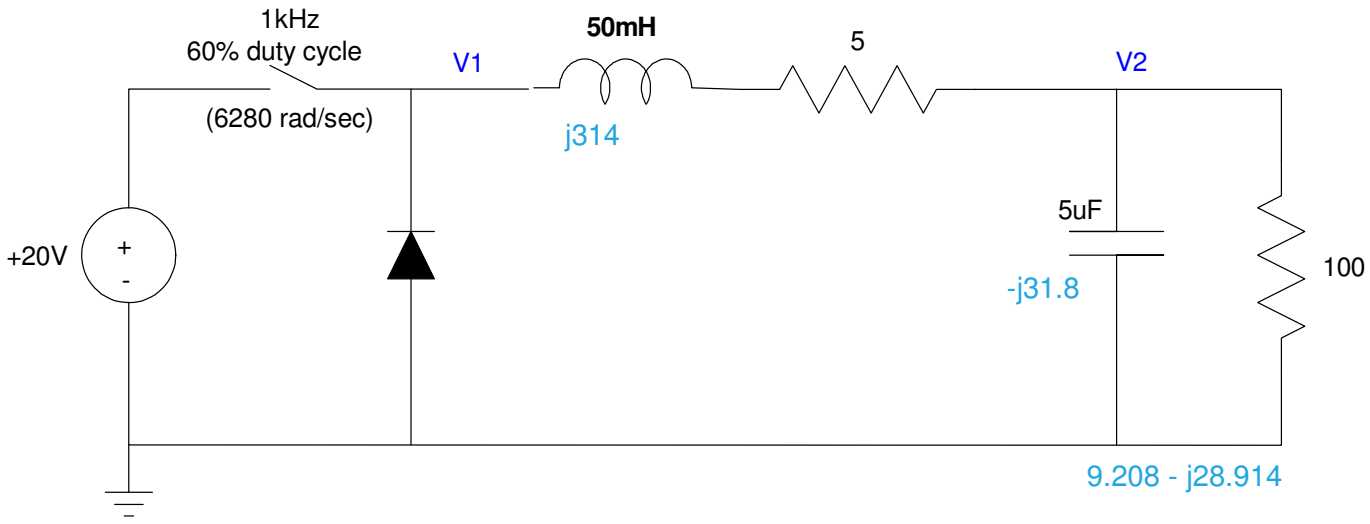
		Calculated	Simulated	Measured
V1 = 5V V2 = 5V	V3	0.20V	86.89mV	0.09V
	I2	-46.0mA	-48.26mA	-48mA
V1 = 0V V2 = 0V	V3	4.80V	4.884V	4.96V
	I2	+46.0mA	+46.87mA	+49mA
V1 = 5V V2 = 0V	V3	2.50V	2.500V	2.46V
	I2	0.0mA	0.0mA	-1mA





DC to DC Converters

4) Determine the voltages (both DC and AC) for V1 and V2.



DC:

$$V_1(DC) = 0.6 \cdot 20V + 0.4 \cdot (-0.7V)$$

$$V_1(DC) = 11.72V$$

$$V_2(DC) = \left(\frac{100}{100+5}\right) 11.72V$$

$$V_2(DC) = 11.16V$$

AC:

$$V_1(AC) \approx 20.7V_{pp}$$

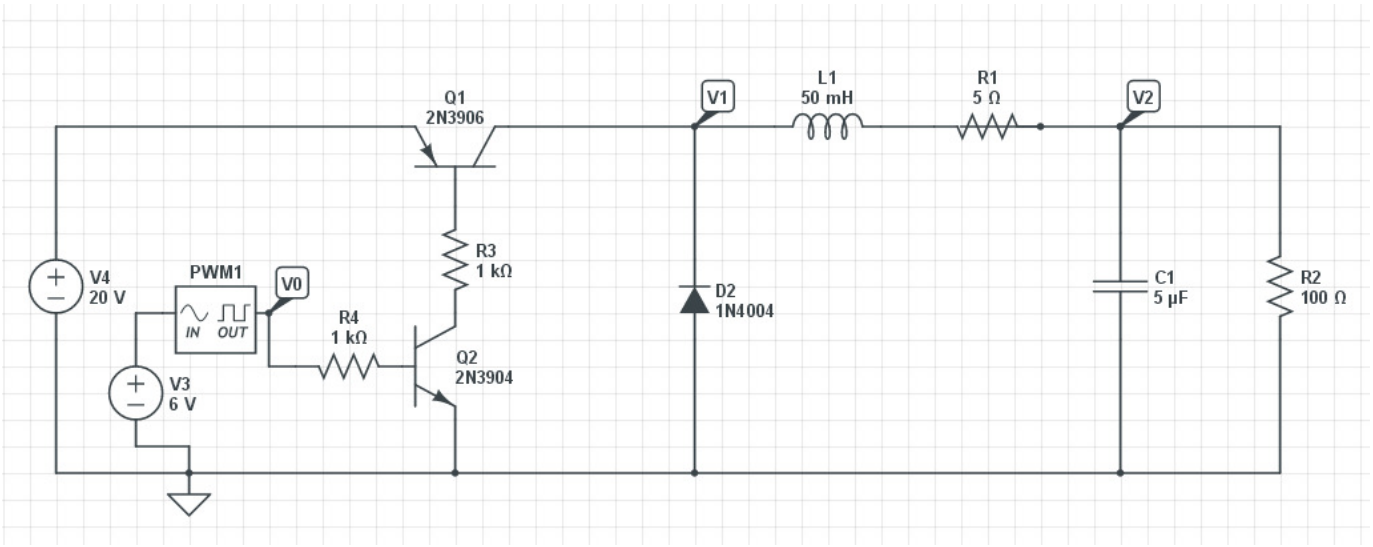
$$V_2(AC) \approx \left(\frac{(9.2084 - j29.9145)}{(9.2084 - j29.9145) + (5 + j314)}\right) 20.7V_{pp}$$

$$V_2(AC) \approx 2.2006V_{pp}$$

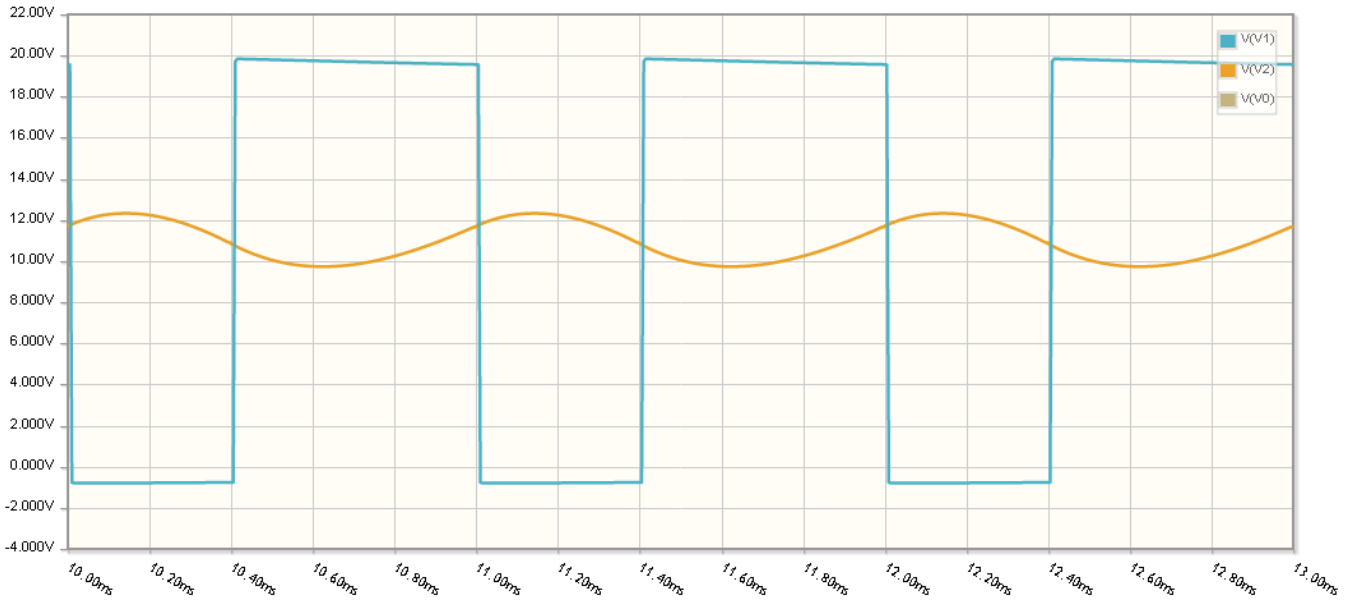
5) Simulate the circuit in CircuitLab and determine V2 (DC and AC)

Use a PNP transistor as an electronic switch.

- Turn it on 60% of the time with PWM



The voltages at V1 and V2 are:



	V1		V2	
	Max	Min	DC	AC
Calculated	20V	-0.7V	11.16V	2.200Vpp
Simulated	19.84V	-0.793V	11.026V	2.588Vpp

6) Change the duty cycle and C so that

- The DC voltage at V2 = 5.00V
- The ripple at V2 is 1Vpp

DC Analysis:

$$V_2 = 5.00V = \left(\frac{100}{100+5}\right) V_1$$

$$V_1 = 5.25V$$

Duty Cycle

$$5.25V = 20V \cdot \alpha + (1-\alpha)(-0.7V)$$

$$\alpha = \left(\frac{5.25V+0.7V}{20V+0.7V}\right) = 28.74\%$$

AC Analysis: (Method #1)

5uF produced 2.588Vpp ripple, so

$$C = \left(\frac{2.588V_{pp}}{1V_{pp}}\right) 5\mu F = 12.94\mu F$$

AC Analysis (Method #2)

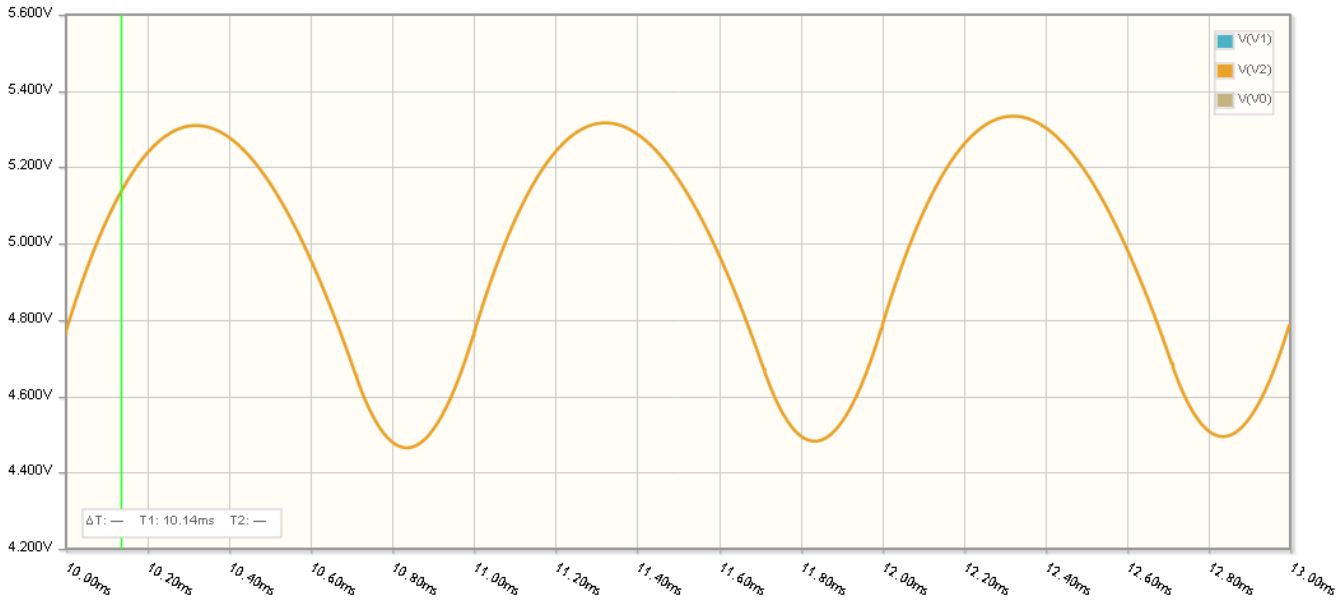
$$V_2 = 1V_{pp} = \left(\frac{R||\frac{1}{j\omega C}}{R||\frac{1}{j\omega C}+(5+j314))}\right) 20.7V_{pp}$$

$$1V_{pp} \approx \left(\frac{\frac{1}{j\omega C}}{j314}\right) 20.7V_{pp}$$

$$\frac{1}{\omega C} \approx 15.17\Omega$$

$$C \approx 10.50\mu F$$

7) Check your results for problem #6 in CircuitLab



	V2(DC)	V2(AC)
Calculated	5V	1Vpp
Simualted	4.891V	0.8500Vpp