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PHYS 219: Experiment 2 – Transients in RC circuits

i) The rough estimate of the time constant

Building the circuit:

- Color scheme: we used yellow for high (function generator, blue to ground)
- Components:
    - We used two 1 microfarad capacitors (the blue ones) in series to provide 0.5 microfarads
    - uncertainties in each: ± 10% of 1 microfarad
    - 1MΩ resistor ± 5%

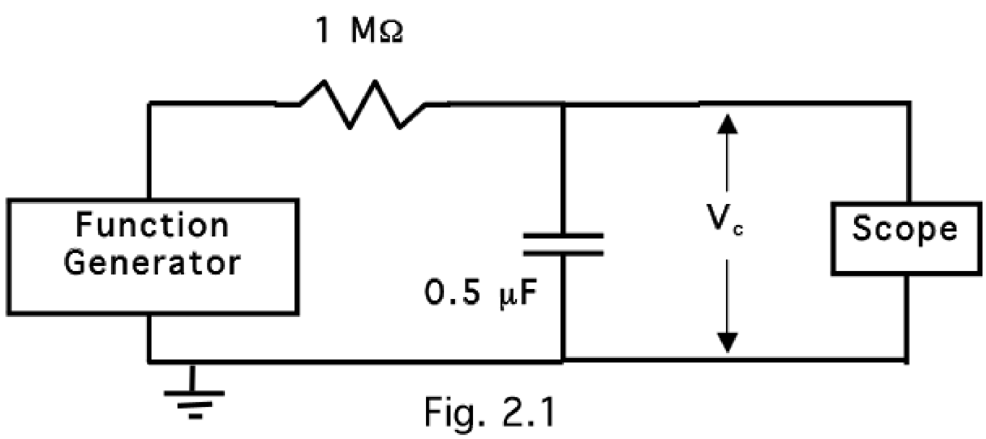


Fig. 2.1

We spent a long time trying to fix the display of the oscilloscope. No TA's were available.

We also accidentally put the capacitors in the same row on the bread board, shorting connection across the capacitors. This was fixed and shall never happen again.

<u>Measurements:</u>

Expected value: tau = (1MΩ * 0.5uF) = 0.5s = 500ms ± 75ms
    delta tau = sqrt((5%)^2 +

Vo = 2.48V at time = -200.0ms ± 4ms
Vo/e = 0.912V at time = 80ms ± 4ms
    uncertainties were obtained by taking turing the knob by one increment and observing the range of the measurement in one increment. This number (8ms) was then divided by two to give an estimate of the uncertainty.
tau = 280ms ± 5.66ms
    delta tau = sqrt((4ms)^2 + (4ms)^2) = 5.66ms

Okay, so obviously the measured time constant does not agree at all with the expected value.

Using the student t test: abs(500-280)/sqrt(5.66^2+75^2) = 2.925
This probably indicates some sort of systematic error caused by the machines we are using. We are not sure what it could be though so we'll just move one to the next part now and see if we get a better result with the next measurement.

Notes: The cursors were in track mode to display the x and y simultaneously. This is definitely an improvement from last year's lab where we only had one one coordinate at a time.
Divisions: 500.0mV ; 200.0ms

ii) Measurements with DMM:

Setting up the circuit:

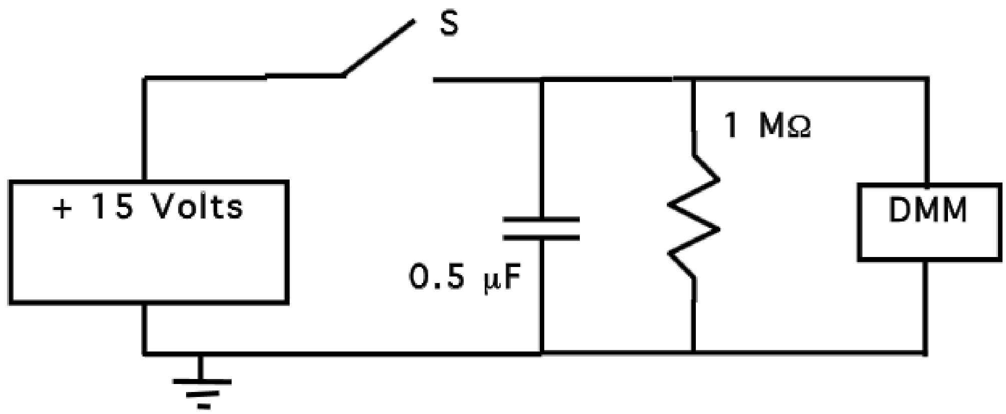
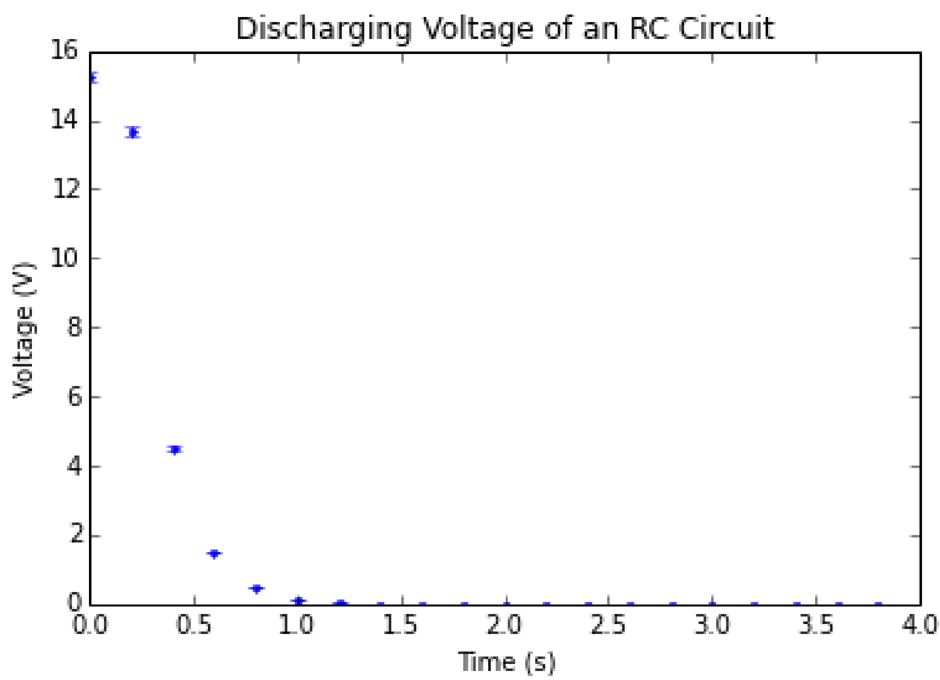


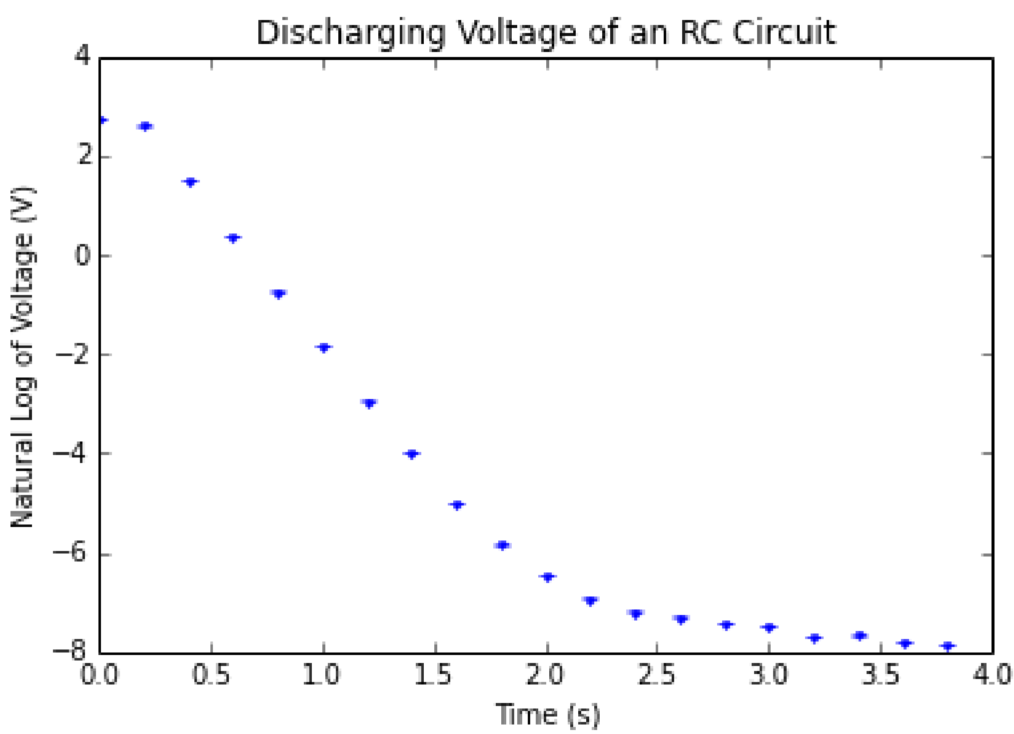
Fig. 2.2

Two 1uF capacitors in series was used in place of the 0.5uF capacitor once again.
DMM uncertainty = 0.1% of reading – from the frequency/period characteristics of the HP DMM package in the Green binder.

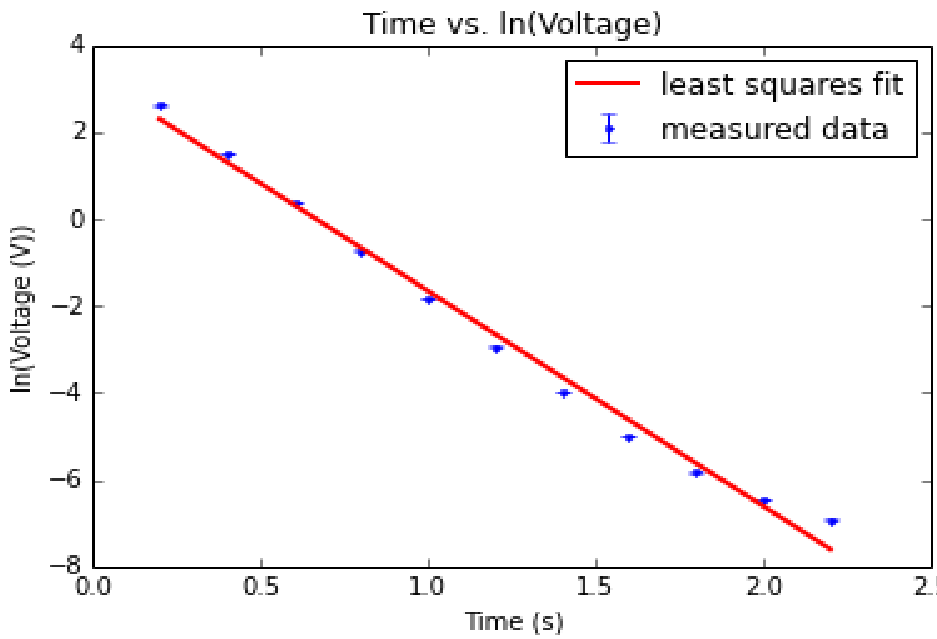
0.0000000	15.2599000
0.2000000	13.6924500
0.4000000	4.5054360
0.6000000	1.4738080
0.8000000	0.4835340
1.0000000	0.1595790
1.2000000	0.0533840
1.4000000	0.0184740
1.6000000	0.0068080
1.8000000	0.0029570
2.0000000	0.0015650
2.2000000	0.0009940
2.4000000	0.0007580

2.60000	0.0006830
2.8000000	0.0006090
3.0000000	0.0005590
3.2000000	0.0004600
3.4000000	0.0004720
3.6000000	0.0004100
3.8000000	0.0003850





So the graph looks really not straight which is probably because the last few points were supposed to be less accurate since they are so small. We decided to find remove the points that did not fit the straight line.



Chi2 = 10432.39, Chi2/dof = 1159.1548 – we probably messed up the uncertainties somehow.

From this graph, we get the time constant to be -1/m, where m is the slope.

m = -4.947e+00 +/- 4.767e-03

tau = 1/4.947 = 0.202 = 202ms

delta tau = (4.947)^-2 * 4.767e-3 = 0.0001947876 = .1947ms

tau = 202ms ± .1947ms

The uncertainties seem to be really small as drawn on the graph and from the magnitude of the chi^2/dof.

T test for the two measurements: abs(202-280)/(sqrt(.1947^2 + 5.66^2) = 13.77, which is pretty bad considering we were measuring the same thing. I think this had to do with the way we calculated uncertainties in the second measurement. Both measurements also disagreed with the calculated (expected value). I'm really not sure why we have three different measurements of the same time constant.