Experiment - I

Familiarization with Lab Equipment and Circuit Analysis

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EE102: Basic Electronics Laboratory

Expt.No.1: Familiarization with Lab Equipment and Circuit Analysis

Objectives:

1. To become familiar with basic components used in building electronic circuits such as resistors, capacitors, inductors, diodes, transistors, breadboards and power supplies.
2. To become familiar with the operation of the function generator and the oscilloscope in the study of waveforms.
3. Building of basis electronic circuits on online real time remote laboratory (VISIR labs of https://iitg.labsland.com).

Pre-lab Work:

1. A sinusoidal waveform is displayed on the screen of an oscilloscope as shown in Fig. 1. The vertical sensitivity (Volt/div) and horizontal sensitivity (time/div) settings are 500 mV/div and 250 μS/div, respectively. Find the frequency and peak-to-peak amplitude of the displayed waveform.

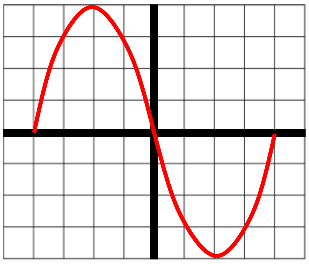

Fig. 1

2. For the potential divider circuit shown in Fig. 2, calculate the currents and the voltages across resistor R2 in for 4 different values of the input DC supply voltage.
3. Calculate the time constants for the RC circuit shown in Fig. 3.

Part A: Use of Function Generator and Oscilloscope

- Set a function generator to output a triangular waveform of 2.3 kHz. Connect the output of the function generator to Channel 2 of an oscilloscope. Adjust appropriate knobs of the oscilloscope to get a stable display of the triangular wave. Note the time scale and number of divisions per cycle on the time axis (x-axis) of the display and calculate the period and frequency of the waveform. Write following observations on the submitted report
  - Time scale =
  - Number of divisions =
  - Period =
  - Frequency =
- With the oscilloscope connected, set the appropriate buttons of the function generator to obtain a square wave of frequency 100 Hz and amplitude 5 Vp-p by doing measurement on the oscilloscope screen (ignore the indicator on the function generator). Note the selected time scale, number of divisions per cycle on x-axis, selected amplitude scale, number of divisions between the peaks on y-axis and verify the frequency and amplitude are as required. Write the following parameters you have set on the oscilloscope on the submitted report
  - Selected time scale =
  - Required number of divisions on x-axis =
  - Selected amplitude scale =
  - Required number of divisions on y-axis =

Part B: Implementation of a Potential Divider and Verification of Ohm's Law

1. Realize on the online breadboard the circuit of the potential divider as shown below

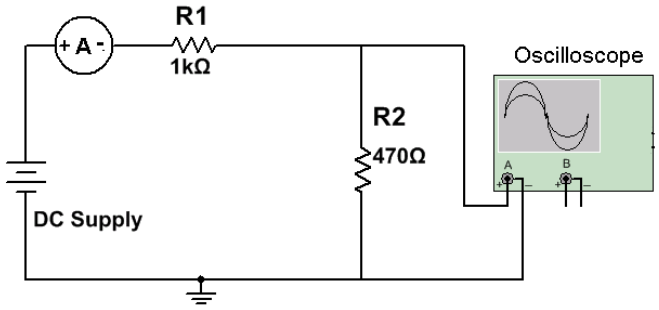

Fig. 2

2. For verification of the Ohm's law, measure the currents in the circuit and the voltages across resistor R2 for 5 variations of input voltage in steps of 0.5 volt.
3. For ease of measurement, use the multimeter as an ammeter and measure the voltage across R2 resistor using any one channel of the oscilloscope.
4. In oscilloscope, use "Quick Measure" function and then select "Average" function to get the precise measurement of the DC voltage.

Part C: Step response of an RC circuit

1. Build the RC circuit shown in Fig. 3.
2. Apply a square wave input (5 Vpp; 100 Hz) from the function generator.
3. Connect Ch1 and Ch2 probes of scope to node A and node B, respectively. Use the dc coupling mode of scope for this part of the experiment.

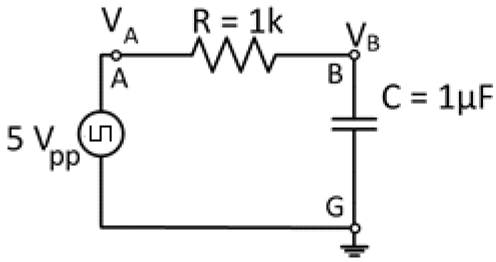

Fig. 3

4. Observe the voltages at node A and node B in the scope and measure the time-constant 'τ' by noting the time taken by the capacitor to rise to 63% of its maximum charge voltage.

5. Alternately, set the frequency of the input signal between 105 to 115 Hz. Now, observe that in each half-cycle, the capacitor just gets charged to the peak value of the input voltage. Theoretically, this half-period is approximately equal to 5 τ. We can compute the time constant of the RC circuit by measuring the half-period time.

Part D: Lab Report

Prepare and submit a lab report as specified in the general instructions regarding this experiment.

1. For Part-A, report your measurements regarding the waveforms studied.
2. For Part-B, draw the V-I characteristics for R2 resistor from the measurements taken and compare it with the ideal V-I characteristics drawn from the pre-lab work.
3. For Part-C, include the screen shot of the waveforms obtained for steps 4 and 5.

Ans 1 Since horizontally its 250 μS/div,

the total time for one complete wave

$= (250\,\mu S/div) \times (8\,div)$

$= 0.002$ seconds

frequency = Number of waves in 1 sec $= \dfrac{1}{0.002}$

$\boxed{\text{frequency} = \cancel{500Hz}\ 500\ Hz}$

Peak-to-Peak amplitude $= (500\,mV/div) \times (8\,div)$

$\cancel{= 0.08\ 3V}$

$\boxed{= 4V}$

Ans 2. Considering Voltages to be 5, 10, 15, 20, neglecting resistance of ammeter and oscilloscope,

Current in $R_2 = \dfrac{V}{R_1 + R_2} = \dfrac{V}{1470}$

Voltage accross $R_2 = \left(\dfrac{V}{R_1 + R_2}\right) R_2 = \dfrac{470}{1470} V$

at $V = 5$, $I_{R_2} = 3.4\ mA$, $V_{R_2} = 1.59\ V$

at $V = 10$, $I_{R_2} = 6.8\ mA$, $V_{R_2} = 3.19\ V$

at $V = 15$, $I_{R_2} = 10.2\ mA$, $V_{R_2} = 4.79\ V$

at $V = 20$, $I_{R_2} = 13.6\ mA$, $V_{R_2} = 6.39\ V$

Ans 3

Time Constant $= RC$

$R = 10^3\ \Omega$, $C = 10^{-6}\ F$

So time constant $= 10^{-3}\ sec = 1\ ms$

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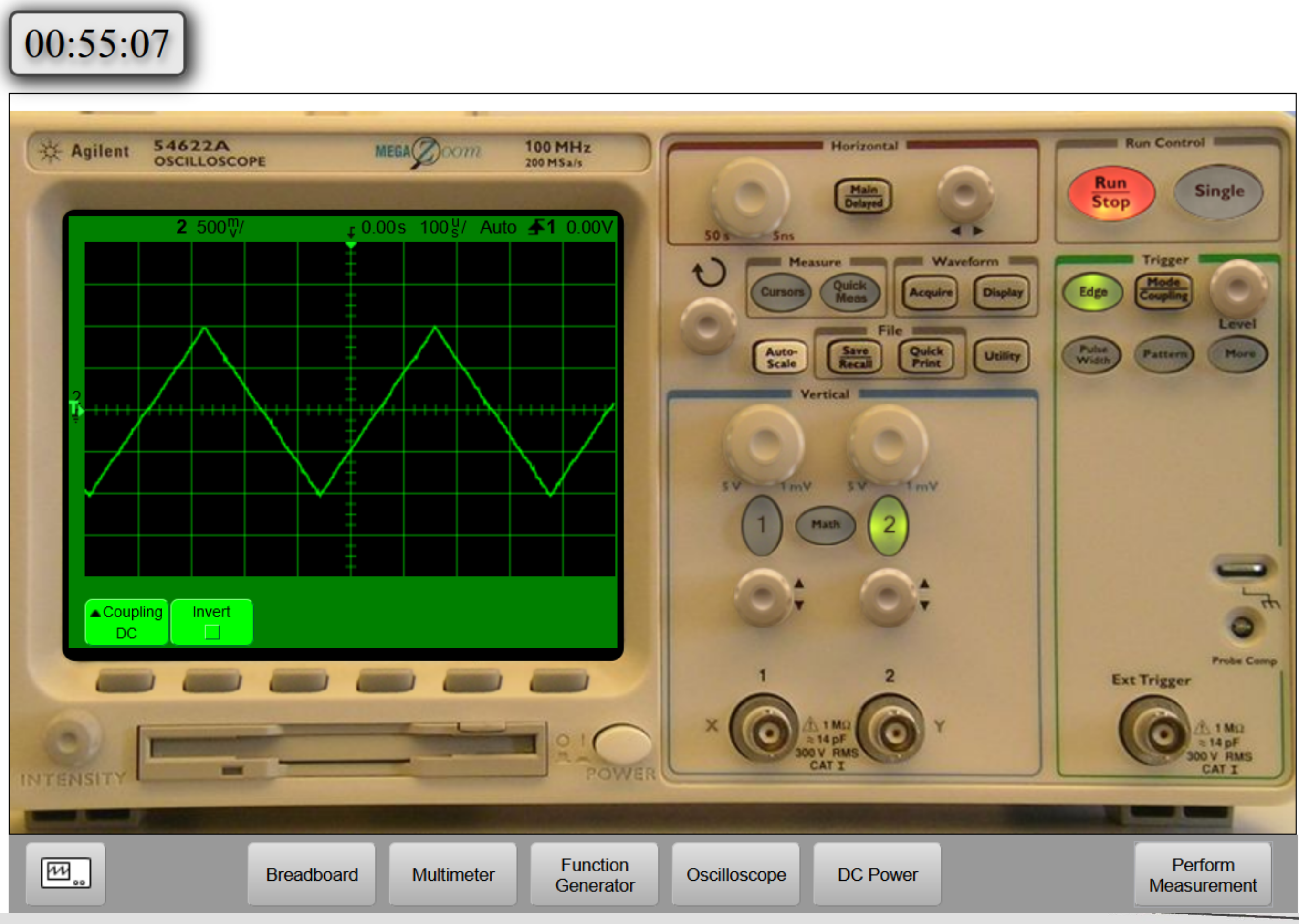
Observations & Answers

PART A: Use of function generator and oscilloscope

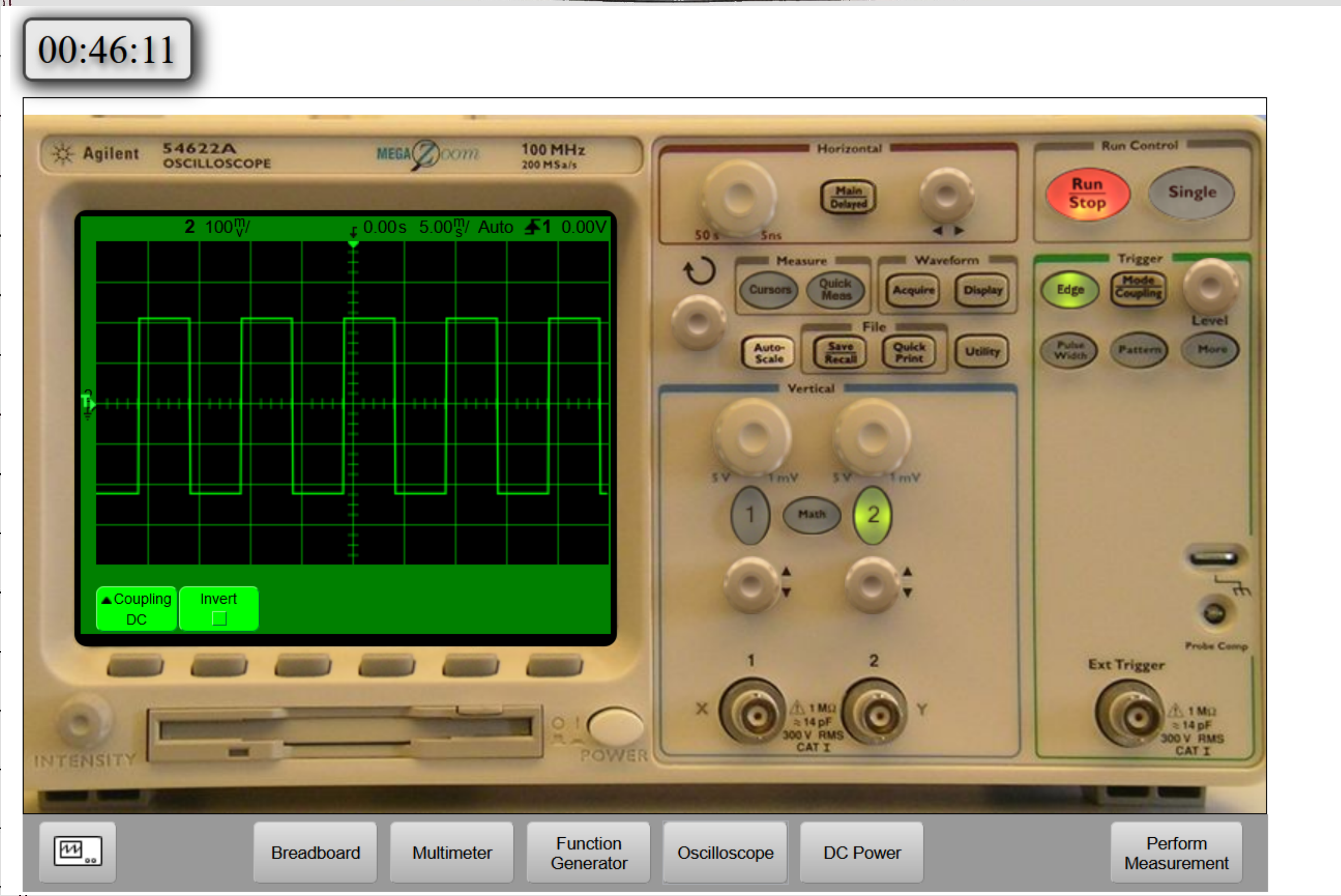
(a) Triangular waveform

- Time Scale = 100 μs
- Number of divisions = 4.4
- Period = 440 μs
- Frequency = 2.27 Hz



(b) Square waveform

- Selected time scale = 5ms
- Req. number of divisions on X axis = 2
- Selected amplitude Scale = 5 V
- Req. number of divisions on Y axis = 2



PART B : Implementation of a potential divider and Verification of Ohm's Law classmate

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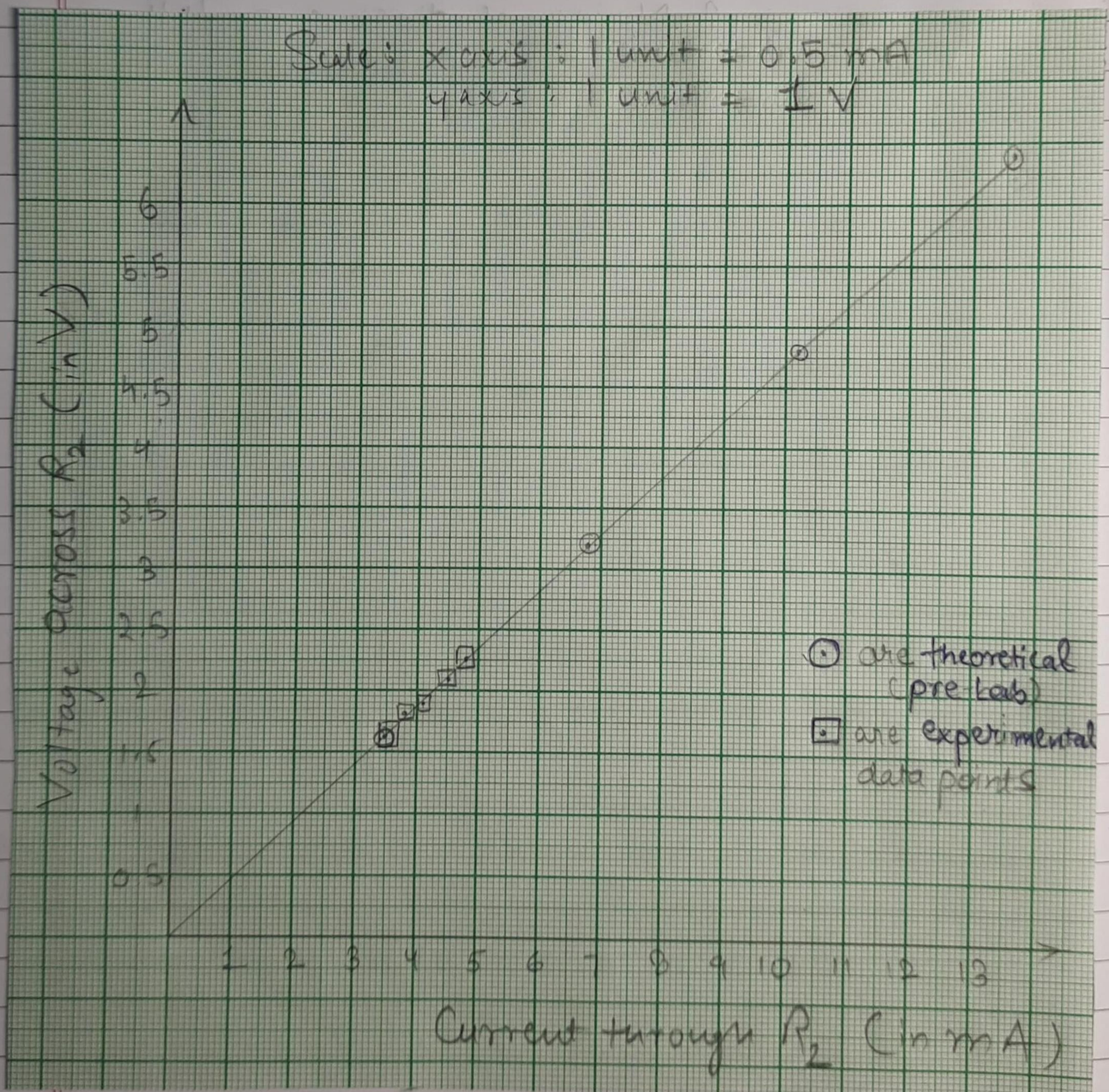
Voltage applied	Current across R_2 in mA	Voltage across R_2 in V
5	3.45	1.61
5.5	3.79	1.78
6	4.13	1.93
6.5	4.47	2.09
7	4.82	2.25

V-I Characteristics



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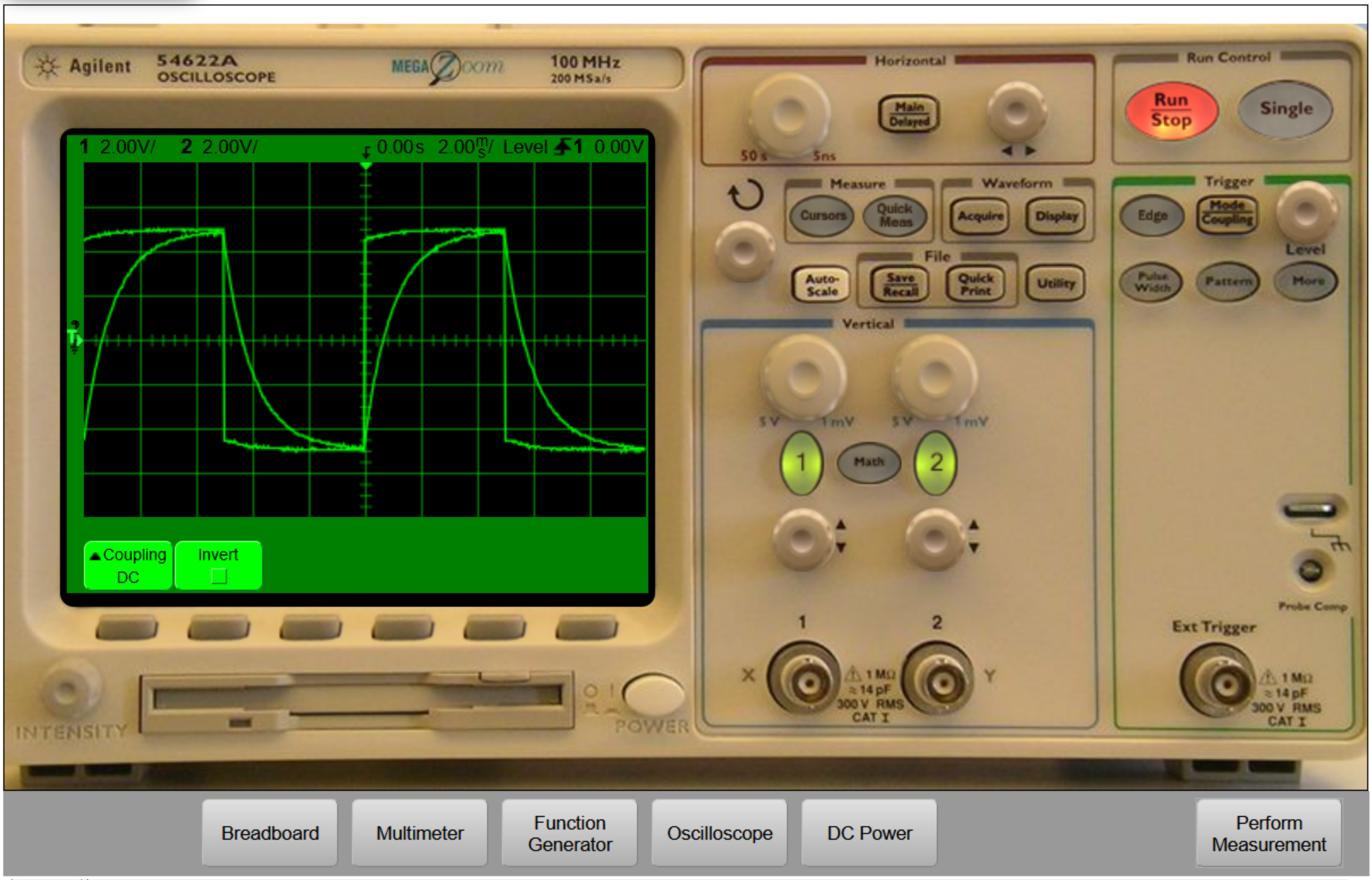
Part C: Step Response of an RC Circuit

At 100 Hz:



Calculations

Time Constant is the time for voltage to rise to 63% (p-p, channel 2) which is

$$(5\text{div} \times 2\text{V/div}) \times \frac{63}{100} = 6.3\text{V}$$

which is reached at $\simeq$ 0.45 div on x axis

$$\tau = (0.45\text{div}) \times (2\text{ms/div}) = \underline{0.9\text{ ms}}$$

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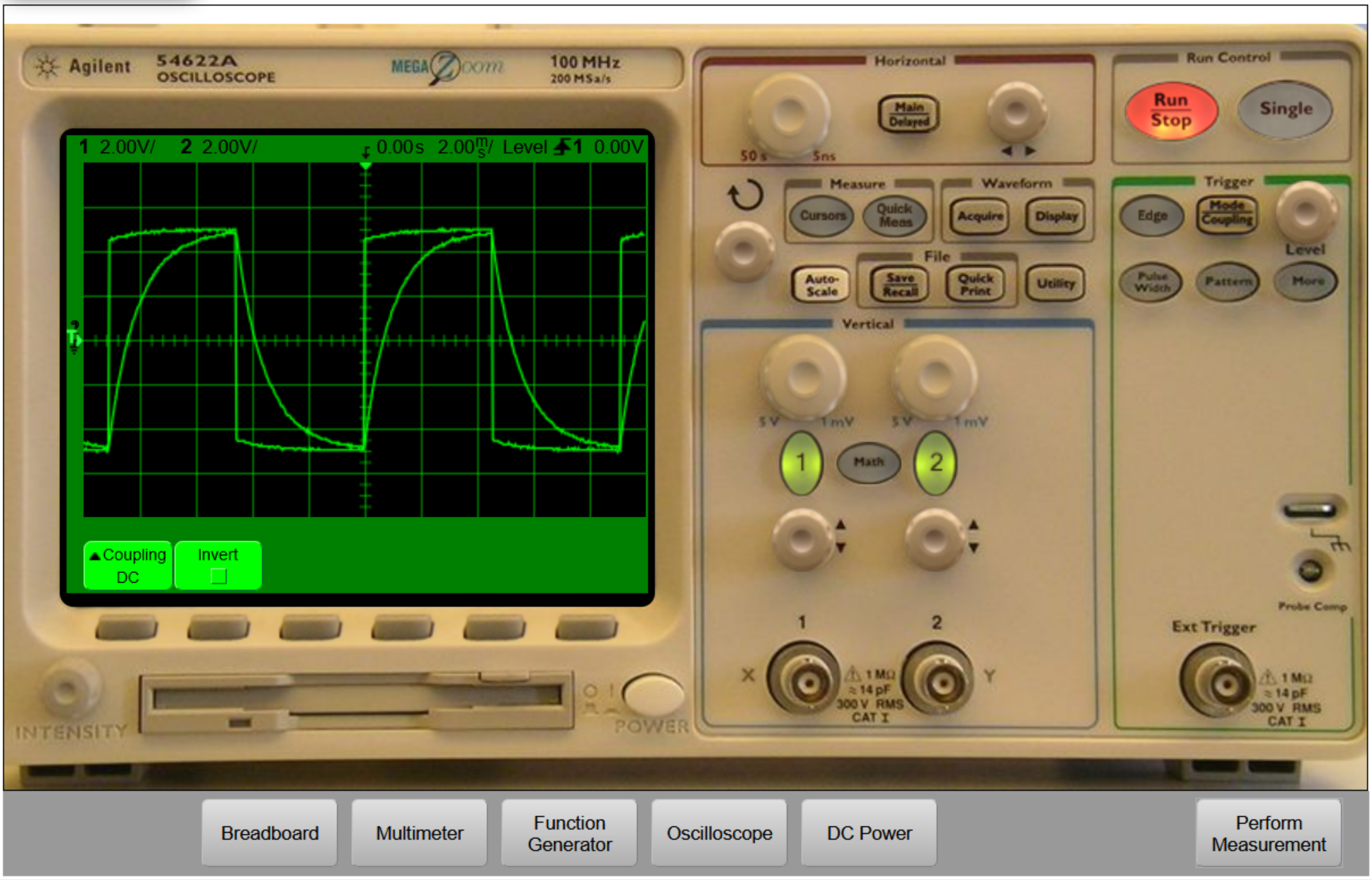
At 110 Hz:



Calculations

$5 \times \tau$ = (half time period)

$\tau = \left(\dfrac{2.2 \text{ div} \times 2 \text{ ms/div}}{5} \right)$

$\tau = 0.88 \text{ ms}$