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Electronic Circuit Testing and Applications

Electronic Control Systems

ACHA4010

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1 Task 1

1.1

$$V = \frac{I}{R}$$

$$\frac{V}{I} = R = \frac{12}{0.5} = 24 \Omega$$

The resistance of E = 24 Ohms

1.2 B

Current of B = 0.1 A

Current of C = 0.1 A

1.3 c (i)

$$R = \frac{V}{I}$$

$$R^A = \frac{12V}{0.3A}$$

Resistance of A = 40Ω

1.4 c (ii)

$$R = \frac{V}{I}$$

$$R^B = \frac{12V}{0.1A}$$

Resistance of B = 120Ω

$$R^C = \frac{12V}{0.1A}$$

Resistance of C = 120Ω

$$R^T = \left(\frac{1}{\frac{1}{R^A} + \frac{1}{R^B} + \frac{1}{R^C}} \right)$$

1.5 c (iii)

$$V = \frac{E}{Q} = Q = \frac{V}{E}$$

1.6 c (iv)

Resistance of D = 0.4 Amps

1.7 d

1.8 e

3 Volts

1.9 f

1.10 g

2 Task 2

2.1 Scope Time Division Calculations

The frequency of the waveform was set to 10Hz giving us the following equations to work out the time per division for the wave to complete a full period.

$$\text{Time Period} = \frac{1}{\text{frequency}} = \frac{1}{10} = 0.1 \text{ seconds}$$

$$\text{Time per division} = \frac{\text{time period}}{\text{number of divisions}} = \frac{0.1}{10} = 0.01 \text{ seconds}$$

2.2 Function Generator output sine wave

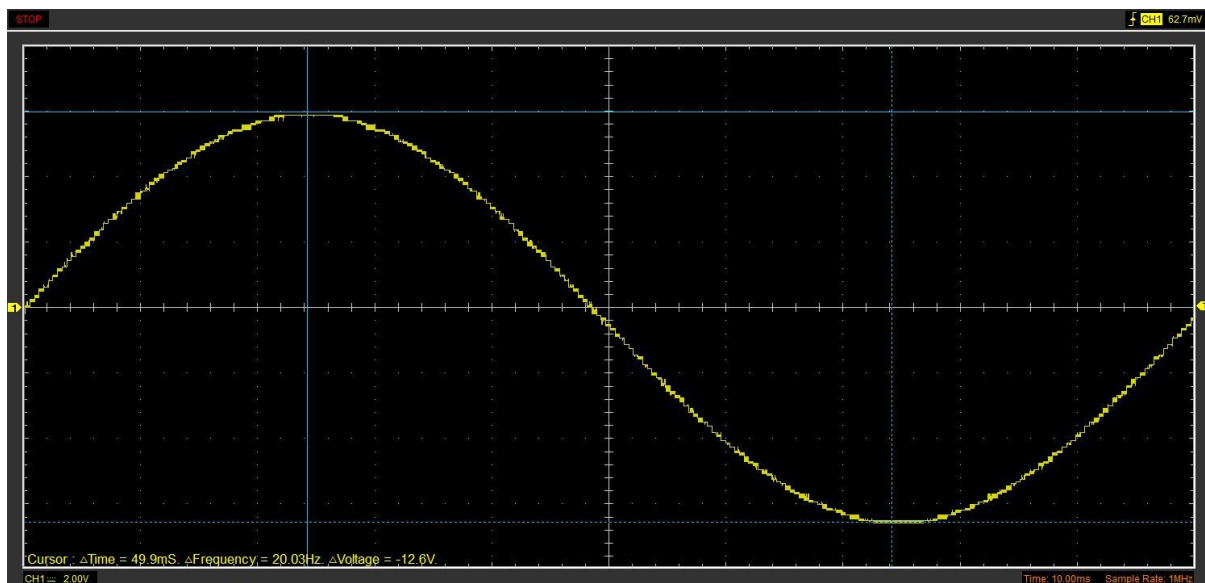


Figure 1 - Function Generator Sine output

Figure 1 above shows the function generator set to give a sine wave output with a voltage of 12.6v

2.3 Unsmoothed Rectifier Wave

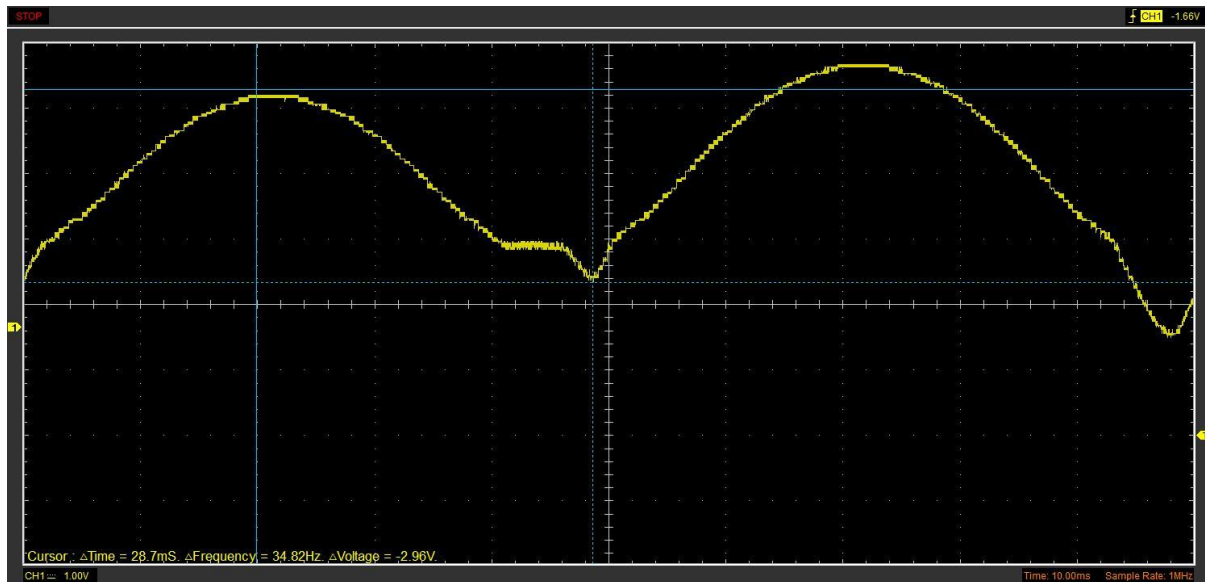


Figure 2 - Unsmoothed Rectifier Sine Wave

Figure 2 above is of the sine wave with an unsmoothed rectifier signal include, this shows a difference in voltage from one peak to another.

2.4 Smoothed Rectifier Wave

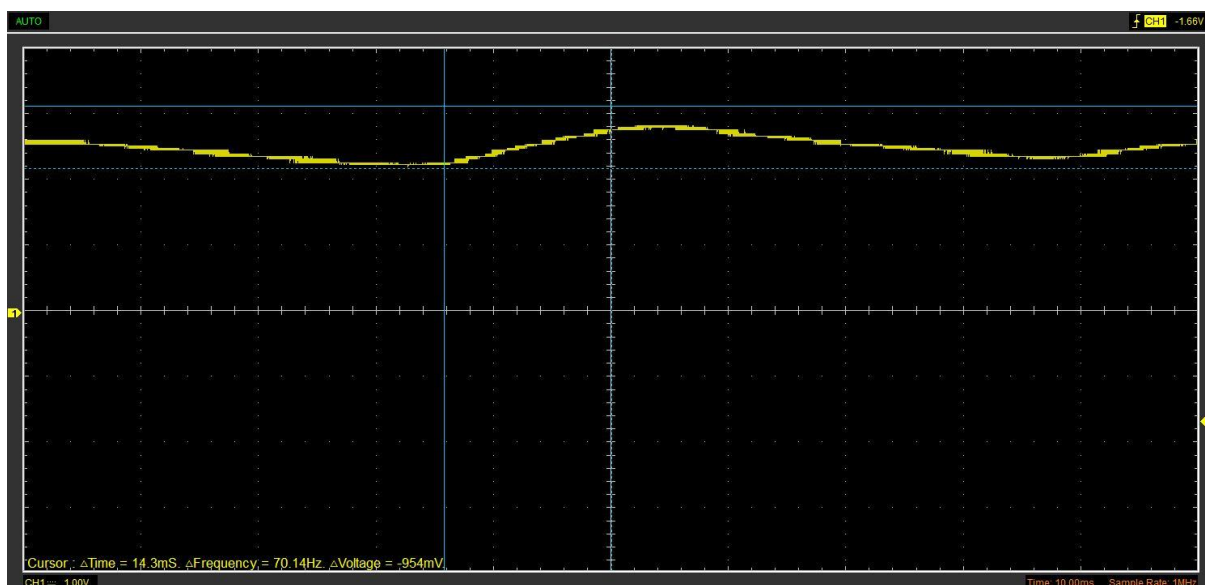


Figure 3 - Smoothed Rectified Sine Wave

Figure 3 is after the sine wave has been smoothed by the rectifier, giving a cleaner and more even voltage with minimal variance. It shows the difference in voltage, frequency and time between the lowest and highest points.

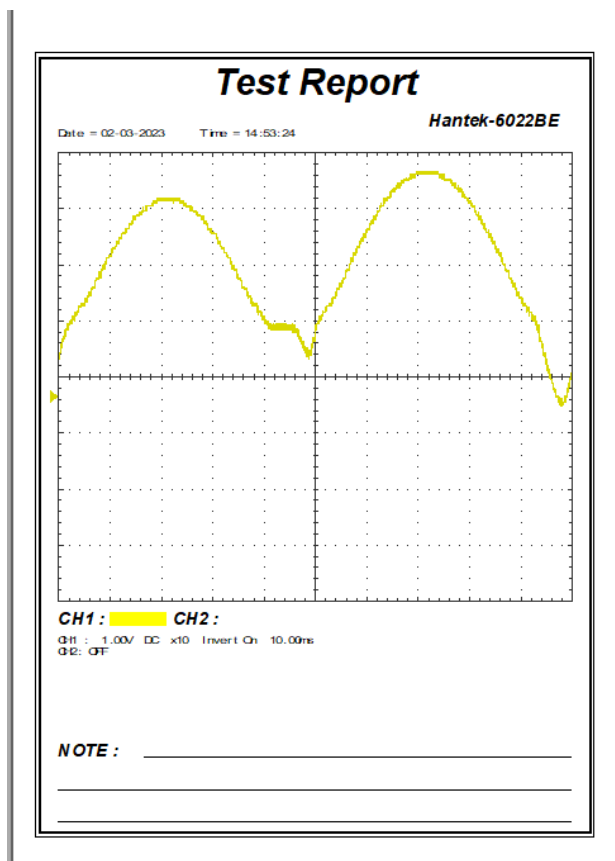


Figure 4 - Complete test of sine wave.

Figure 4 shows us the complete positive sine waveform from the experiment.

2.5 Drop in Voltage Question

The output DC voltage of the rectifier is lower than the peak of the sinewave input due to several factors. One factor is that the DC current is only allowing the forward direction current whilst blocking the reverse direction creating a fixed DC voltage level, this results in the reading not being as pure as the initial voltage applied to the signal. Another factor is that in a practical rectifier, the output waveform will be 0.7volts less than the applied input voltage due to the forward voltage drop.

2.6 Rectifiers use in Automotive applications Question.

Rectifiers are used in the automotive industry around the world for a variety of reasons. They are used in the electronic systems from engine management including the ignition system, the radio and entertainment system, collision detection sensors and navigation control.

In traditional automotive applications where an Internal Combustion Engine (ICE) is being used, a 12-volt battery will be paired with a three-phase generator also known as an alternator with the responsibility of generating and rectifying an Alternating Current into Direct Current to power the electronics of a vehicle.

Rectifiers are an important factor in the electrification of automotive vehicles and Plug-in EVs where the electricity to charge them is first met by the rectifier, due to the increased current of these vehicles multi-phase rectifiers will be used due to their increase in load capability.

2.7 Probing Question

One potential issue when probing the input of a function generator and the output of a rectifier simultaneously is the possibility of creating a short circuit if the ground connections of the oscilloscope probes are connected to two different potentials. This could damage the equipment. To avoid this, it is important to ensure that the ground connections of the oscilloscope probes are connected correctly.

Another potential issue is that the function generator may not have enough output current to drive the load, which could result in unexpected measurements. It is important to check the function generator's output with an oscilloscope to ensure that it has the expected voltage amplitude while it is connected to the full wave rectifier.

3 Task 3

3.1 Scope Time Division Calculations

3.2 Function Generator output square wave

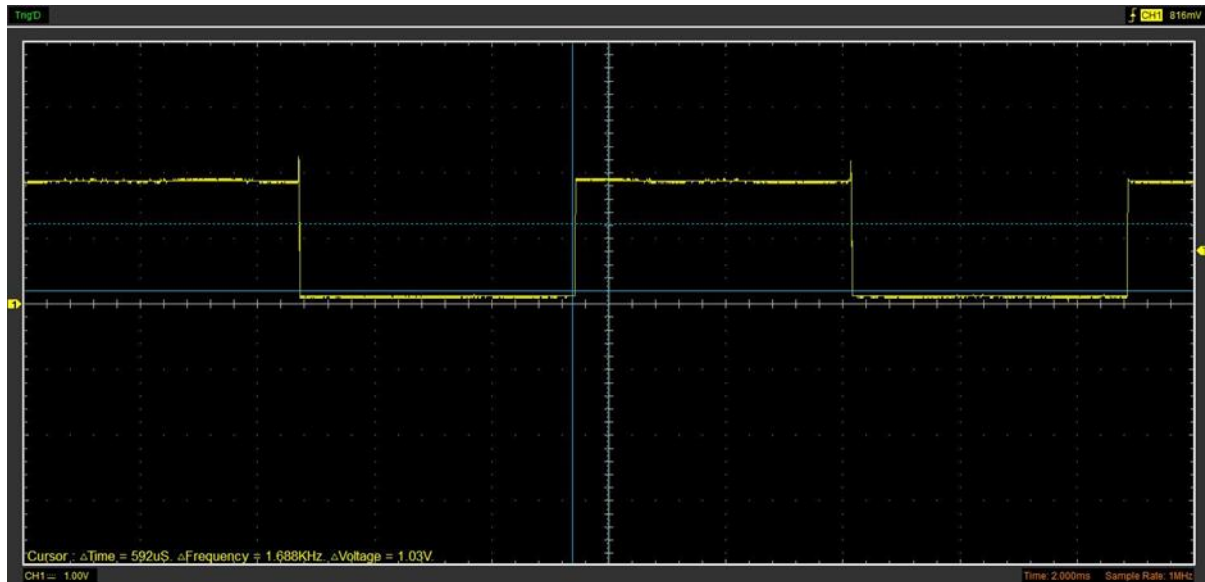


Figure 5 - Square wave function of generator output

Figure 5 is the function generator with a smoothed square wave with a peak of 1.03V.

3.3 Capacitor charge and discharge wave marked at correct points.

3.4 Basic Capacitor Calculations

3.5 Capacitor discharge table

Table 1 - Capacitor Discharge table results

Index	Time (s)	Voltage(Ln)
1	0.034795	0.632547558
2	0.035995	0.632547558
3	0.037195	0.450183502
4	0.038395	0.093490343
5	0.039595	-0.242963679
6	0.040795	-0.571460662
7	0.041695	-0.753746803
8	0.044495	-1.38230234
9	0.047995	-1.852146619
10	0.050995	-2.07544952

Table 1 above is a selection of 10 points during the discharging of the capacitor in the experiment. It gives us the gradient shown in fig 6 and the log of the voltage during that time period.

3.6 Gradient Plot and calculations

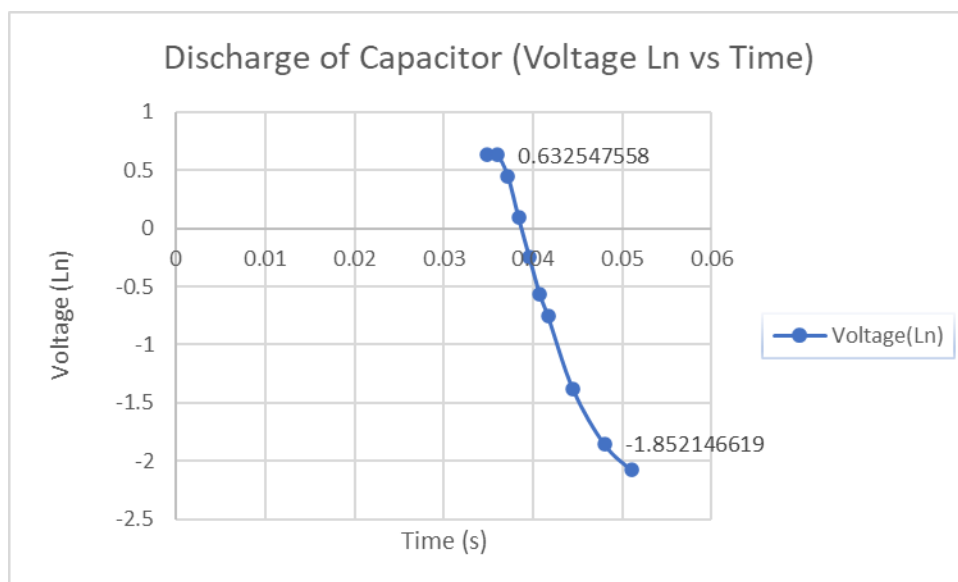


Figure 6 - Discharge plot of Capacitor results.

Figure 6 is a graph of the resultant discharge cycle of the capacitor and the log of the voltage drop across the time and the two selected points of the cycle.

3.7 Inaccuracies Question

4 References

Comparison of a designed virtual oscilloscope with a real oscilloscope - University of Wales Trinity Saint David (2015). Available at:

https://librarysearch.uwtsd.ac.uk/discovery/fulldisplay?docid=cdi_doaj_primary_oai_doaj_org_article_722a4d0778304090b917da12baeb7626&context=PC&vid=44WHELF_UWTSD:44WHELF_UWTSD_VU1&lang=en&search_scope=Search_ELEC&adaptor=Primo%20Central&tab=Everything&query=any,contains,oscilloscope%20function%20generator&offset=0.

‘Digital Scopes Conquer 1 GHz; These instruments have a great deal more to offer than “simply” oscilloscopes, with the capabilities of logic analyzers, function generators, and protocol analyzers included’ (2012) *Microwaves & RF* [Preprint], (3).

Torriente-García, I., Muñoz-Pérez, F.M., Marti, A.C., Monteiro, M., Castro-Palacio, J.C. and Monsoriu, J.A. (2023) ‘Experimenting with RC and RL series circuits using smartphones as function generators and oscilloscopes’. Available at: <https://arxiv.org/abs/2303.16249v1>