

ELECTRONIC CIRCUITS TESTING AND APPLICATIONS

**Electrical Control Systems
ACHA4010**

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1 Task 2

1.1 Scope Time Division Calculations (4)

$$f = \frac{1}{\text{Period}} \text{ \& Period} = \frac{1}{f}$$

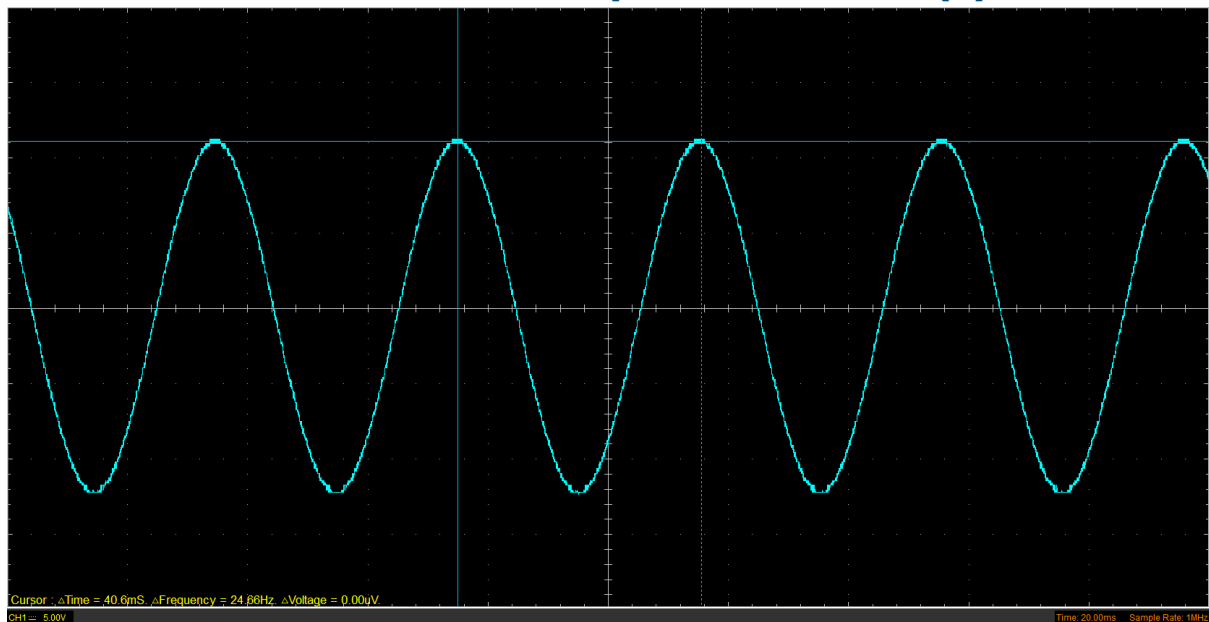
$$f = 10$$

$$\text{Period} = \frac{1}{10}$$

$$\text{Division} = 10$$

$$\frac{1}{10} / 10 = \frac{1}{100} \text{ seconds or } 100\text{mS (100mS on the function generator)}$$

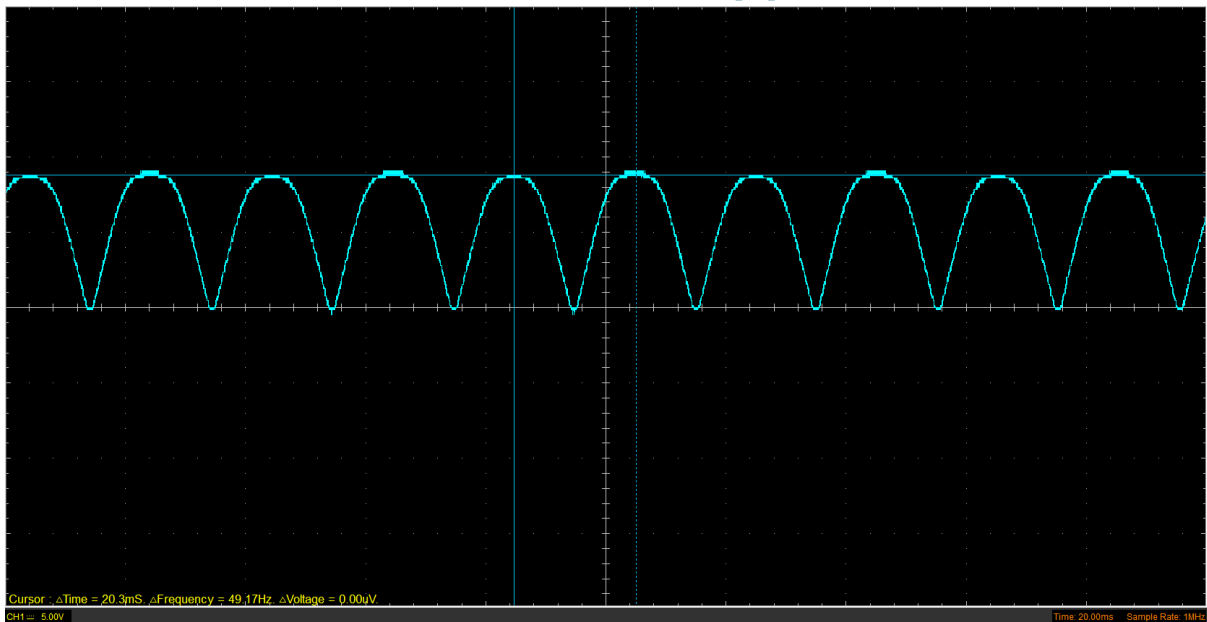
1.2 Function Generator output sine wave (3)



Time = 40.6mS

Frequency = 24.66Hz

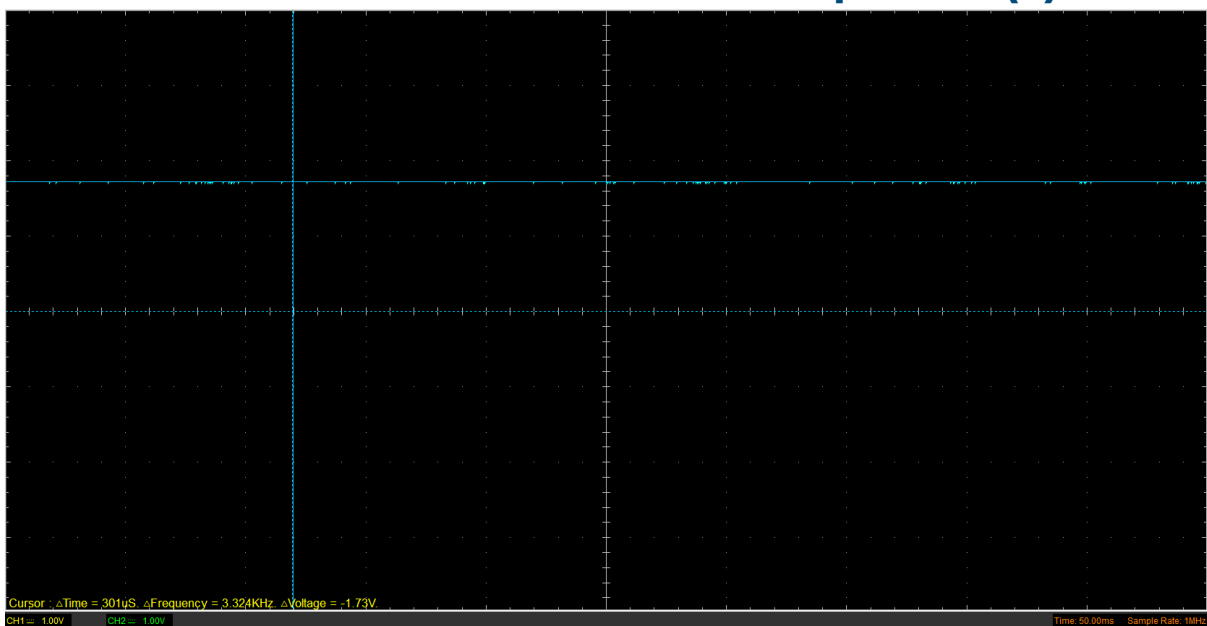
1.3 Unsmoothed Rectifier Wave (3)



Time = 20.3ms

Frequency = 49.17Hz

1.4 Smoothed Rectifier Wave with capacitor (3)



Voltage = 1.73V

1.5 Drop in Voltage Question (4)

The voltage drop seen between the sinewave input and the rectifier output is due to a small amount of voltage being dropped over the components of the full bridge rectifier circuit. A small amount of voltage is dropped over all 4 of the diodes within the circuit because a “forward-biased diode conducts current and drops voltage across it” (All About Circuits, n.d.). This is why the rectifier output is roughly a volt lower than the sinewave input.

1.6 Different Voltage Readings Question (5)

Peak Positive Input Voltage	Peak to Peak Voltage	RMS
2.25V	4.72V	1.59V

$$\text{RMS} = \sqrt{\frac{A^2}{2}} \text{ therefore, } \text{RMS} = \sqrt{\frac{2.25^2}{2}} = 1.59\text{V}$$

The RMS of a waveform “indicates the equivalent steady state energy value of an oscillating signal” (Bifulco, 2021). The oscillating signal in this case is the sine wave input. RMS is a consistent value that is slightly lower than the peak voltage, the latter of which only occurs twice within a waveform (BBC Bitesize, n.d.). This supports the values observed in the table above which show a higher peak voltage than RMS.

1.7 Rectifiers use in Automotive applications Question. (4)

A rectifier’s purpose is to convert alternating current (AC) into direct current (DC) (All About Circuits, n.d.). This proves useful in many cases such as providing polarised voltage during welding or signal peak detectors in AM radios (BYJU'S, n.d.). However, from an automotive perspective the biggest use case for a rectifier is to “convert alternating electricity (AC) from the alternator into direct current (DC) for the battery and the rest of the electrical system” (Mughees, 2023) to use. This conversion to DC happens “due to its greater efficiency and cheaper cost” (Mughees, 2023) in comparison to AC.

1.8 Probing Question (4)

2 Task 3

2.1 Scope Time Division Calculations (4)

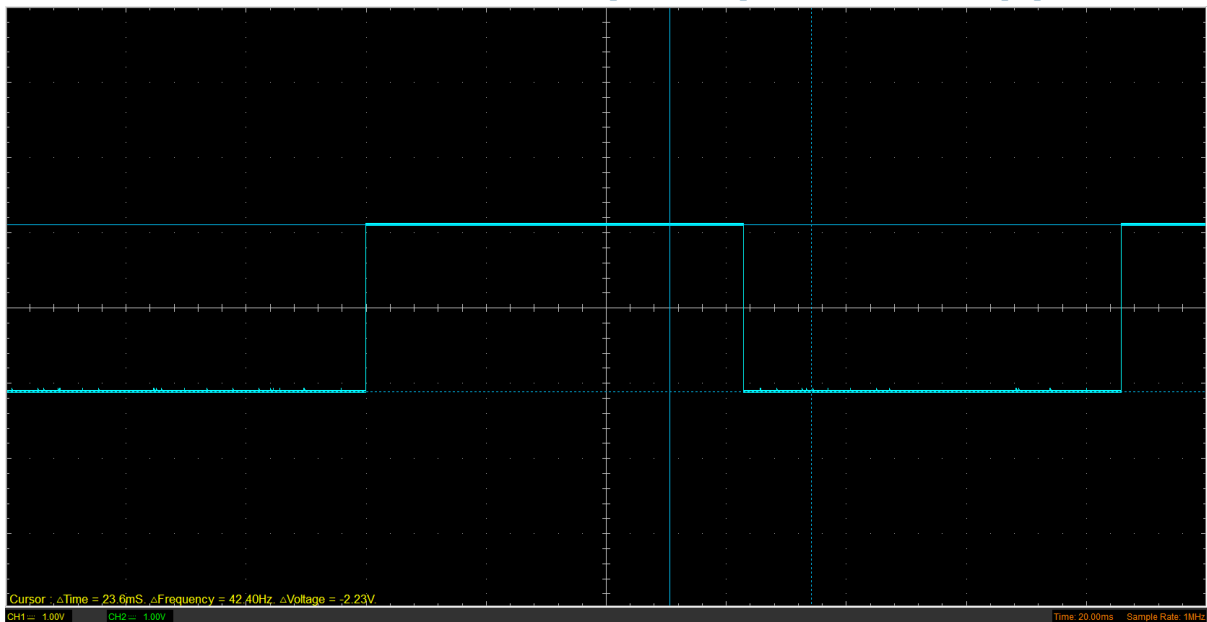
Frequency = 8.3Hz

$$\text{Period} = \frac{1}{8.3}$$

Division = 10

$$\text{Time division} = \frac{\frac{1}{8.3}}{10} = \frac{1}{83} \text{ seconds or } 120\text{mS (200mS on the function generator)}$$

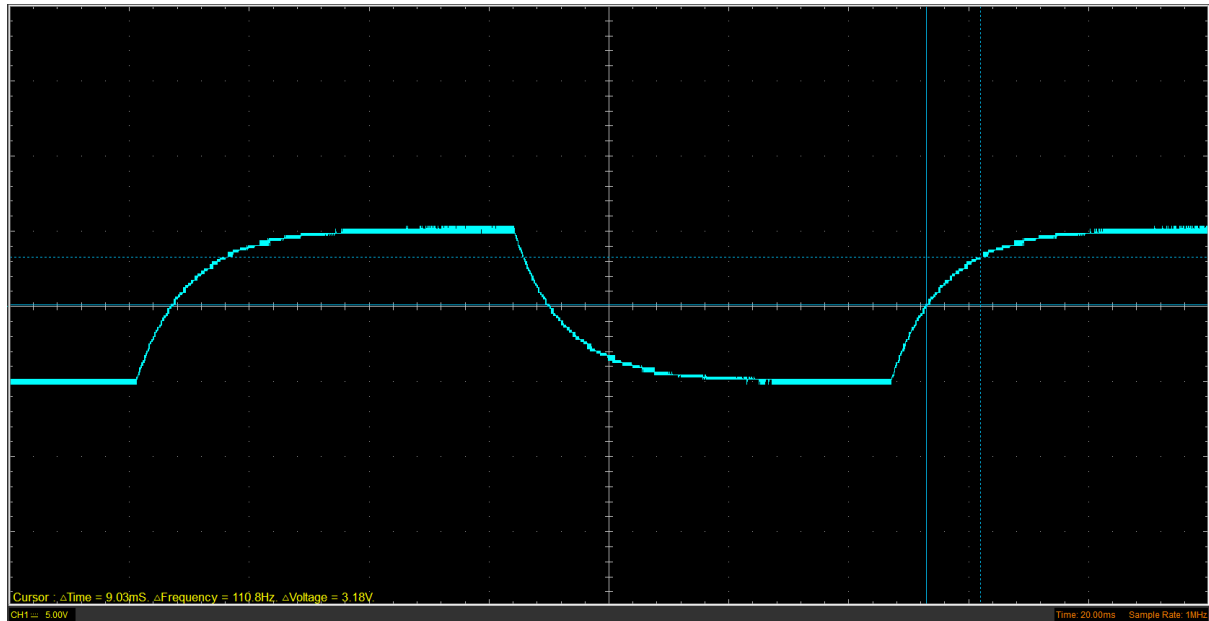
2.2 Function Generator output square wave (3)



Time = 23.6mS

Frequency = 42.40Hz

2.3 Capacitor charge and discharge wave marked at correct points. (3)



Peak Voltage = 5V

$$(\text{Peak}(V) - \text{Start}(V)) \times 63.2\% + \text{Start}(V) = \text{Time Constant}$$

$$(5V - 0V) \times 0.632 + 0V = 3.16V$$

2.4 Basic Capacitor Calculations (3)

Resistor = 100k Ohms

$$\tau = 9.03\text{mS or } 9.03 \times 10^{-3} \text{ seconds}$$

$$\tau = R \times C$$

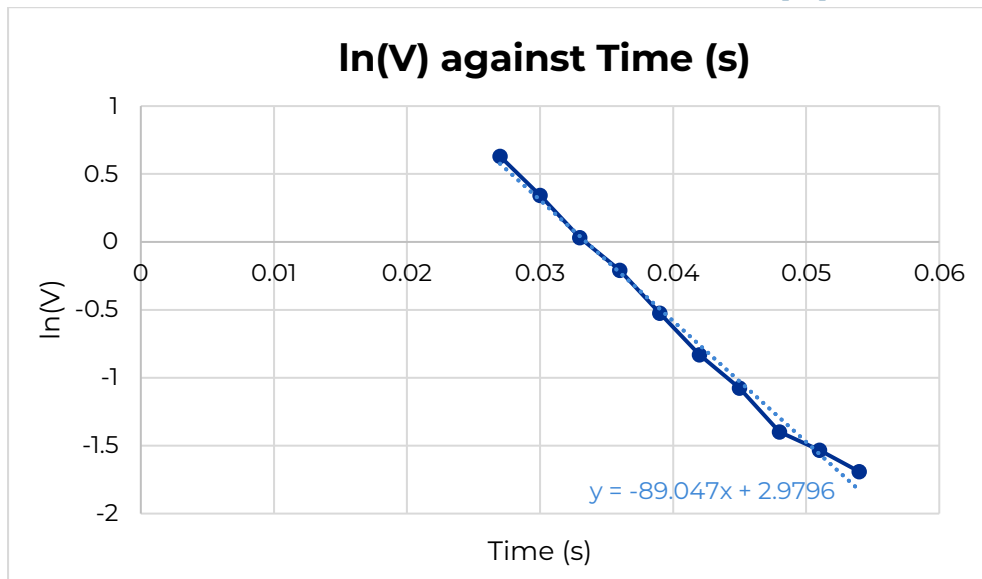
$$C = \frac{\tau}{R}$$

$$C = \frac{9.03 \times 10^{-3}}{100 \times 10^3} = 90.3 \times 10^{-9} \text{F or } 90.3\text{nF}$$

2.5 Capacitor discharge table (4)

Time (s)	Voltage (V)	ln (V)	$dy = y_2 - y_1$ $dy = \ln(V)_2 - \ln(V)_1$	$dx = x_2 - x_1$ $dx = \text{Time}_2 - \text{Time}_1$	dy/dx
0.02699	1.8784	0.63042	x	x	x
0.02999	1.4078	0.342028	-0.288392148	0.003	-96.1307
0.03299	1.0314	0.030917	-0.3111111	0.003	-103.704
0.03599	0.8118	-0.2085	-0.239418377	0.003	-79.8061
0.03899	0.5922	-0.52391	-0.315409589	0.003	-105.137
0.04199	0.4353	-0.83172	-0.307808967	0.003	-102.603
0.04499	0.3412	-1.07529	-0.243566633	0.003	-81.1889
0.04799	0.2471	-1.39796	-0.322675703	0.003	-107.559
0.05099	0.2157	-1.53387	-0.13590456	0.003	-45.3015
0.05399	0.1843	-1.69119	-0.157323689	0.003	-52.4412

2.6 Gradient Plot and calculations (4)



$$\text{Gradient (m)} = -\frac{1}{RC}$$

$$RC = -\frac{1}{m}$$

$$RC = -\frac{1}{-89.047}$$

$$RC = 0.011\tau$$

$$\tau = R \times C$$

$$C = \frac{\tau}{R}$$

$$C = \frac{0.011}{100000} = 110 \times 10^{-9} \text{ or } 110\text{nF}$$

$$\frac{90.3\text{nF}}{110\text{nF}} \times 100 = 82.09\%$$

$$100 - 82.09 = 17.91\% \text{ decrease from the calculated capacitance}$$

2.7 Capacitor Uses (5)

As automotive vehicles increase in complexity and more electrical systems are introduced, more capacitors are needed to help these systems operate. "From steering to braking to seat height adjustment, if the car system begins with "power," it probably employs capacitors" (Arrow Electronics, 2018). Capacitors are "primarily used in the electrical systems for energy storage purposes" (Working Reseach, 2023). These systems include headlights, on board chargers for electric cars, sensors for monitoring the drivetrain or tyre pressures, DC to DC convertors to scale voltage down from 48V to 12V for motors and systems as well as control systems such as battery regeneration (Holy Stone Enterprise, n.d.).

2.8 Inaccuracies Question (4)

The results gathered from the full bridge rectifier circuit test and the capacitor circuit test could be inaccurate due to two main factors. The first of these is human error as the knowledge and understanding of the components being assembled on the breadboard circuit as well as the equipment being used to measure their output was limited. The second main cause for inaccuracies in the test results could have been the equipment itself as it was not the highest quality and "Inferior or inappropriate leads can lead to erroneous measurements, potentially causing misdiagnosis or even damage to the equipment being tested" (Wang, 2023).

3 References

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