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Function Generator

ACHA4010 Electrical Control Systems

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1 Task 2

1.1 Scope Time Division Calculations (4)

$$T = \frac{1}{\text{period}}$$

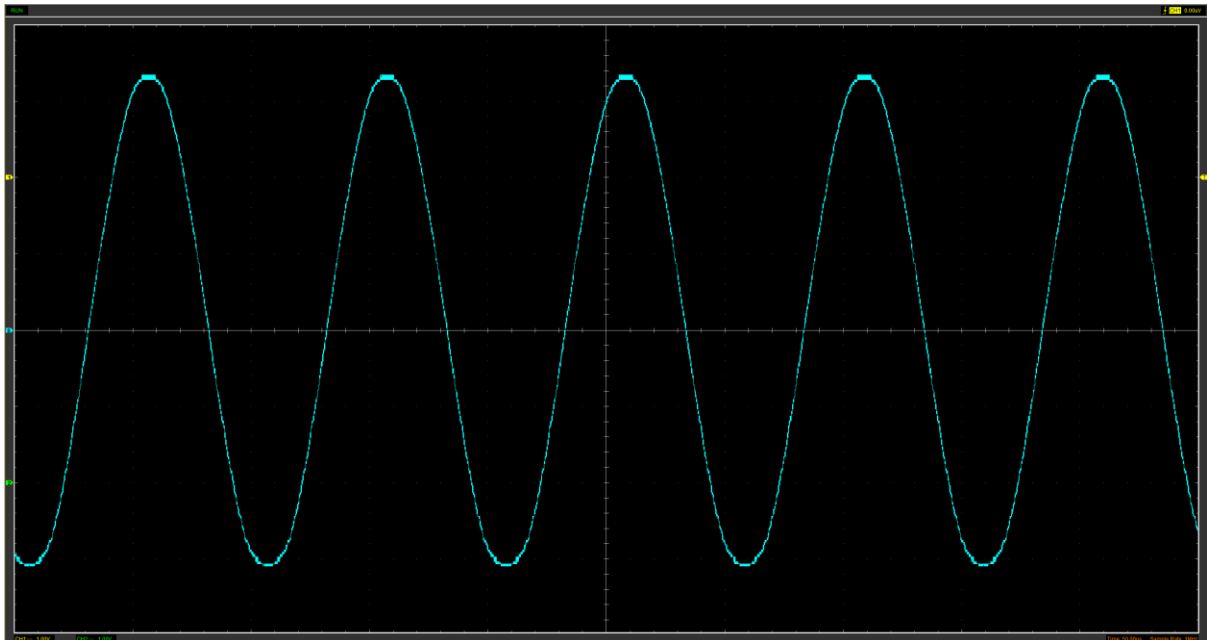
$$\text{Frequency} = 10\text{hz}$$

$$\text{period} = \frac{1}{f}$$

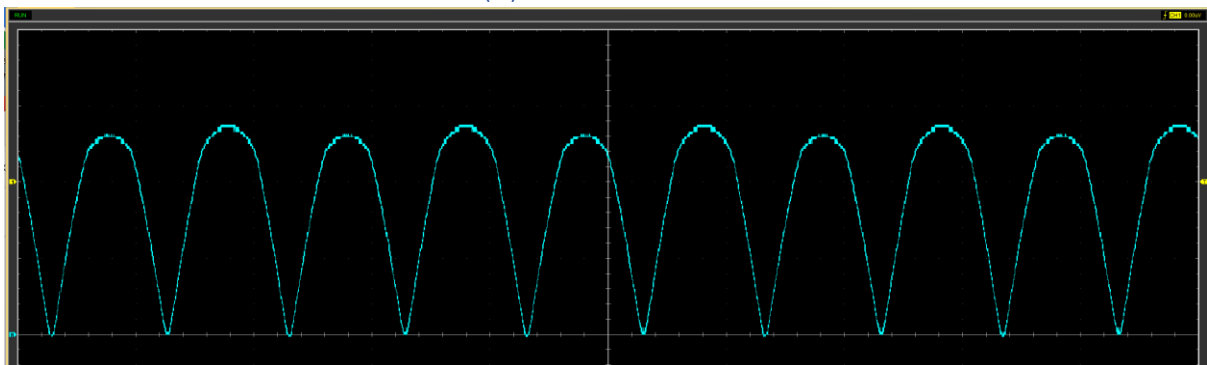
$$\text{period} = \frac{1}{10} = 0.1 \text{ seconds}$$

$$\text{Time} = 0.1 \text{ seconds}$$

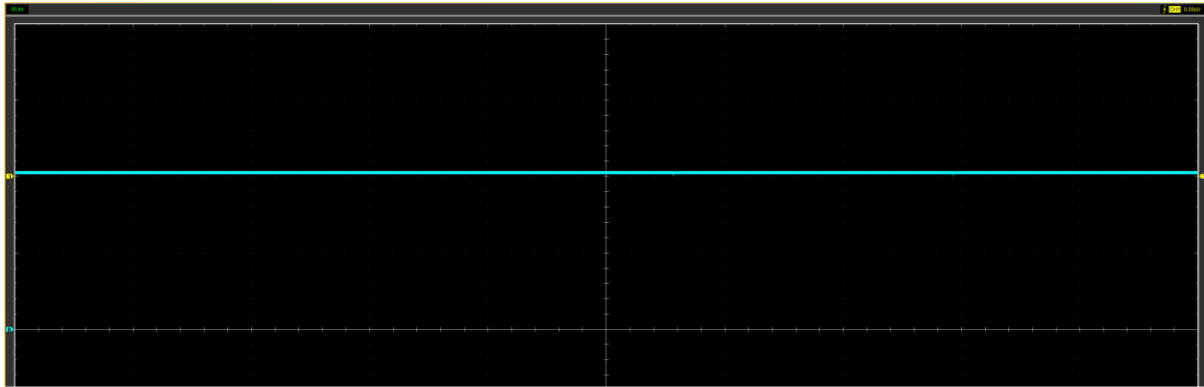
1.2 Function Generator output sine wave (3)



1.3 Unsmoothed Rectifier Wave (3)



1.4 Smoothed Rectifier Wave with capacitor (3)



1.5 Drop in Voltage Question (4)

When a rectifier converts AC (alternating current) to DC (direct current), there is often a drop in the DC output voltage compared to the peak voltage of the AC input waveform. This drop, known as the voltage drop occurs due to several factors, diode voltage drop, transformer regulation, resistance in circuits components, filtering capacitor ripple voltage, voltage drop across load.

(Circuits, 2019)

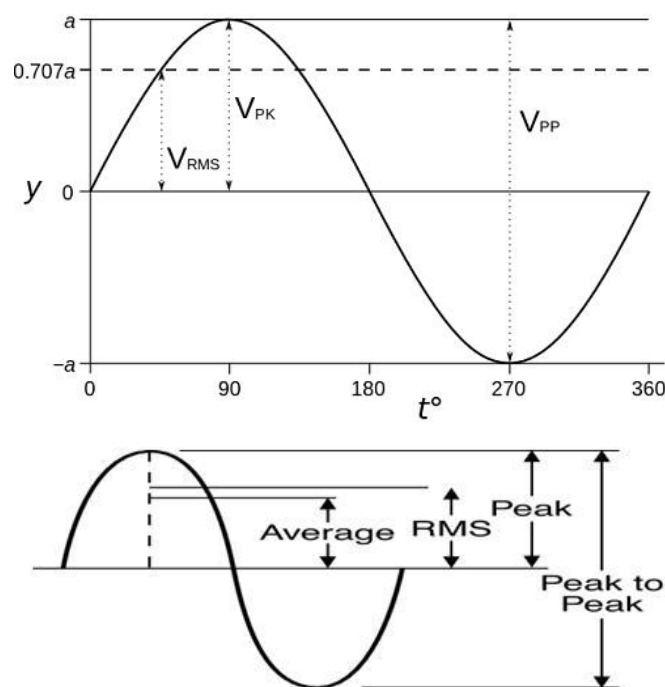
1.6 Different Voltage Readings Question (5)

VRMS stands for "Root Mean Square Voltage." It's a measure of the effective voltage of an alternating current (AC) waveform. In AC circuits The root mean square voltage is a way to represent the same DC voltage that would produce the same amount of power dissipation into resistance.

(electronics, 2020)

For a sinusoidal waveform, the peak voltage (V_{peak}) is the maximum voltage reached by the waveform. The VRMS is calculated as the square root of the average of the squares of all instantaneous voltages over one complete cycle of the waveform.

(Ling, 2019)



Peak positive input voltage (V _{pk})	Peak to peak voltage (V _{pp})	RMS (V _{rms})
3.87V	873V	2.47V

$$V_{rms} = \frac{1}{\sqrt{2}} \times V_{pk}$$

$$V_{rms} = \frac{1}{\sqrt{2}} \times 3.87$$

$$V_{rms} = 2.47V$$

1.7 Rectifiers use in Automotive applications. (4)

Rectification, is the process of converting alternating current (AC) to direct current (DC), and is essential in many vehicle systems.

Charging systems in cars,

The rectification process is crucial in the vehicle's alternator, which generates alternating current as the engine runs. Converting this AC to DC is vital for charging the battery and powering the vehicle's electrical systems.

Electrical power steering (EPS),

EPS systems in modern vehicles use electric motors to assist in steering. These motors require dc power to operate efficiently and precise, rectifiers convert the AC power from the vehicles electrical system into DC power needed to drive the electric motor in the EPS system.

Fuel Injection systems,

Electronic fuel injection (EFI) systems in vehicles require precise control of fuel delivery for optimal engine performance and efficiency. Rectification ensures stable DC power for the electronic control unit (ECU) and fuel injectors.

Ignition Systems,

Both traditional spark ignition systems in internal combustion engines and modern electronic ignition systems rely on stable DC power to generate sparks at the spark plugs.

Auxiliary systems in motorcycles,

Motorcycles often have auxiliary systems such as lighting, instrumentation, and electronic accessories that require DC power to operate reliably.

(arrow, 2018)

1.8 Probing Question (4)

You are unable to simultaneously probe the input of a function generator on one channel and the output of a rectifier on another channel with an oscilloscope because they share a common ground. The Oscilloscope has a single ground reference point for all channels. When the ground clip of one channel is connected to a certain point in the circuit, it becomes the reference point for all other channels. This will create a short circuit, if you try and connect the ground clip of another channel to a different point in the circuit. To allow simultaneous probing of both the function generator input and the rectifier output, you can use isolated oscilloscope probes or differential probes.

Isolated oscilloscope probes, have their ground reference isolated from the oscilloscope chassis ground. They are typically battery powered or optically isolated ground this would mean the grounds wouldn't short if connected to the same circuit

Differential probes have two inputs and measure the voltage difference between them. They allow you to measure signals across two points in the circuit without connecting to the ground.

Using isolated oscilloscope probes or differential probes effectively resolves the ground reference issue, enabling you to make accurate measurements of multiple points in the circuit simultaneously without causing interference or short circuits.

(Brophy, 2024)

2 Task 3

2.1 Scope Time Division Calculations (4)

$$Resistor = 10K\Omega$$

$$Capacitor = 104 \times 10^{-6} \text{ farads}$$

$$Time \text{ period} = 10000 \times 104 \times 10^{-6} \times 20$$

$$Time \text{ period} = 20.8 \text{ seconds}$$

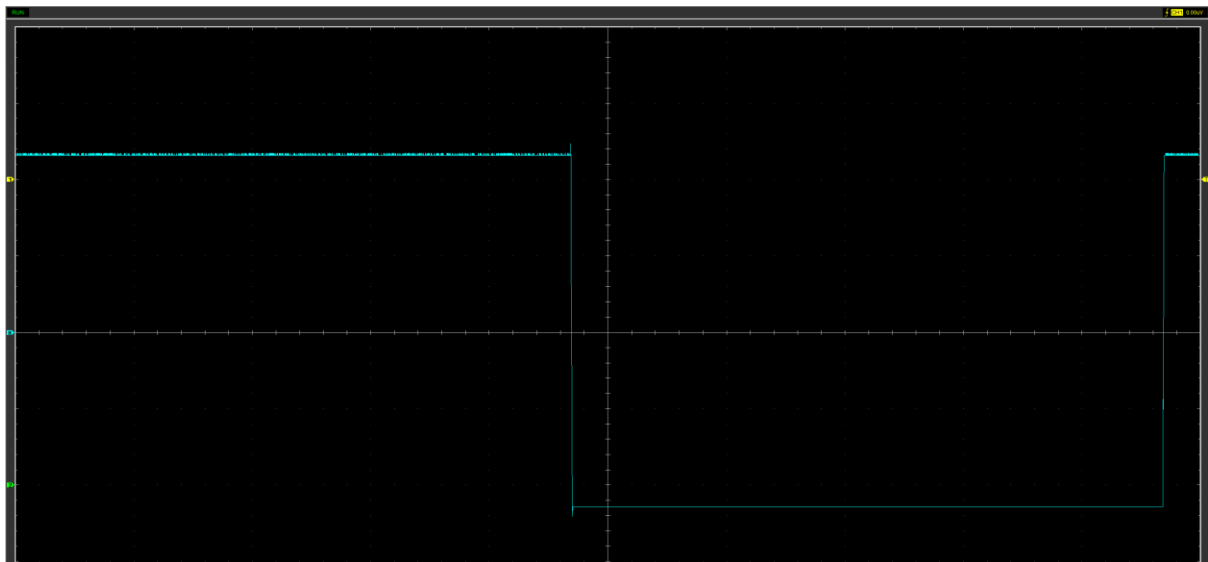
$$Time \text{ division} = \frac{20.8}{10}$$

$$Time \text{ division} = 2.08 \text{ seconds}$$

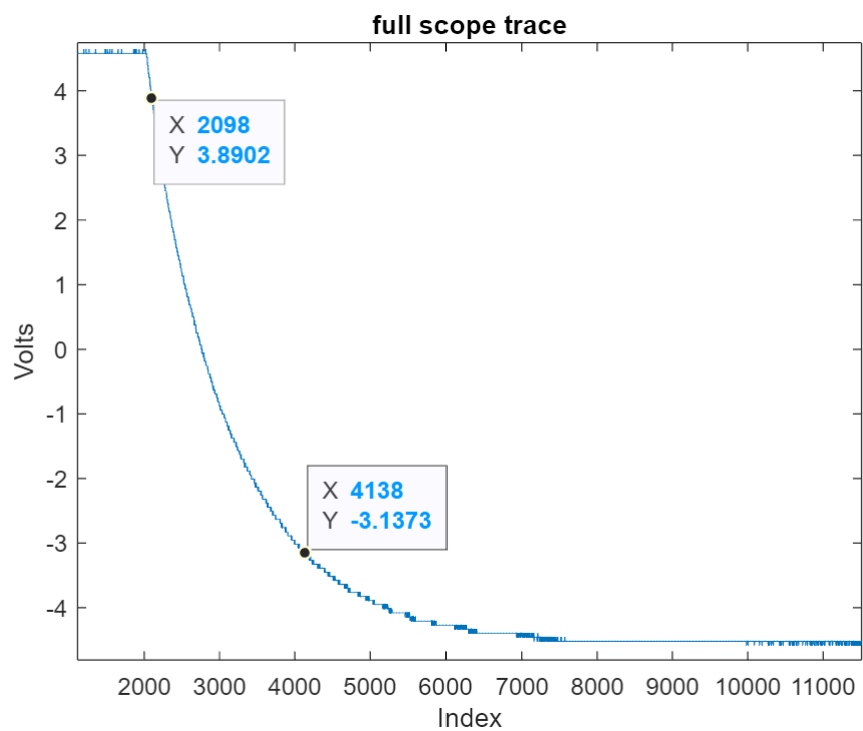
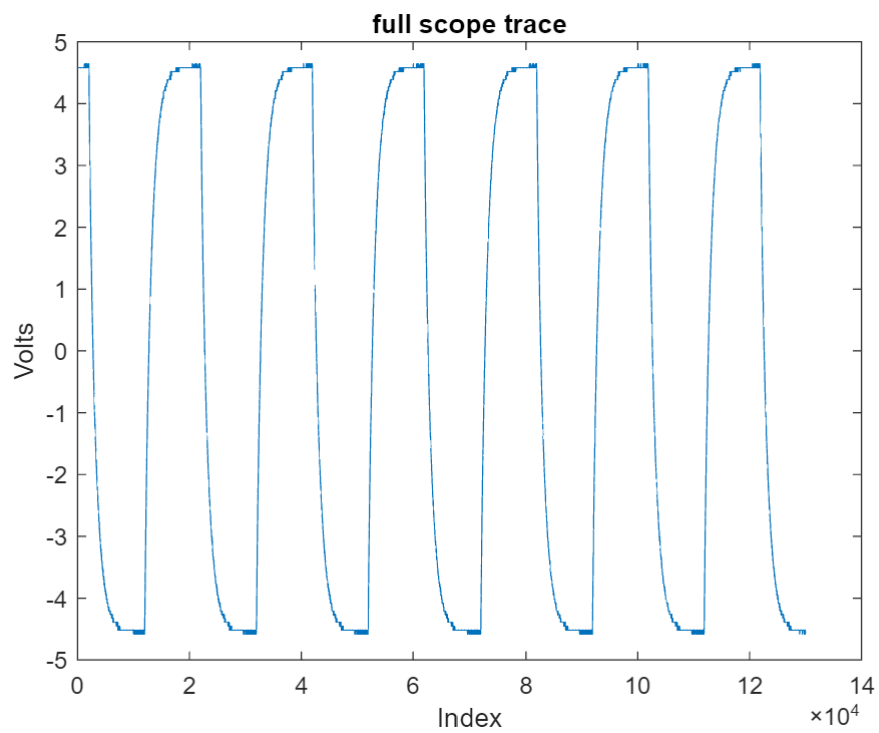
$$Frequency = \frac{1}{2.08}$$

$$Frequency = 0.48 \text{ Hz}$$

2.2 Function Generator output square wave (3)



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



2.4 Basic Capacitor Calculations (3)

Gradient = $\frac{dy}{dx}$ where $y = \ln(V)$ and $x = t$

$$R \times C = \tau = \frac{1}{-\text{Gradient}}$$

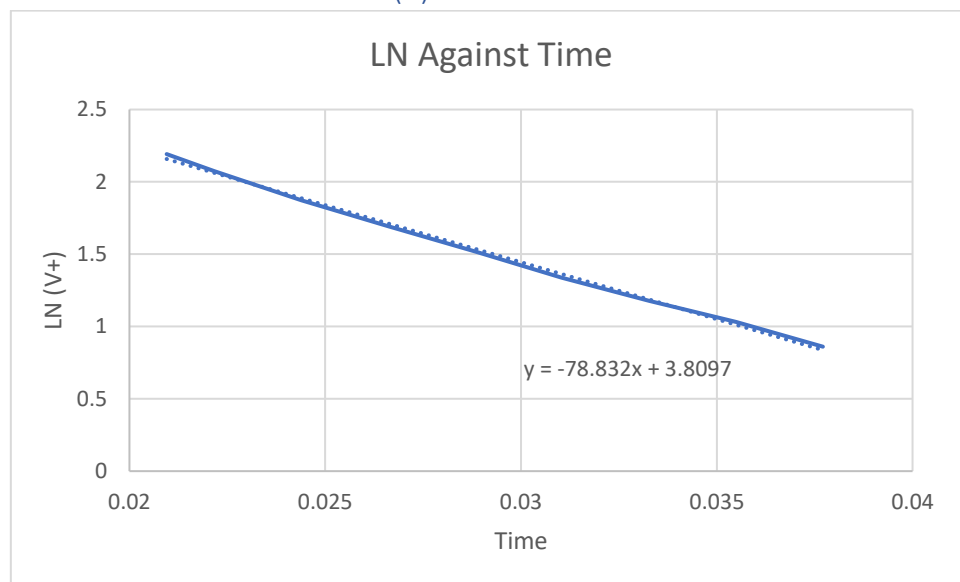
$$C = \frac{\tau}{R}$$

Capacitor = 1.1579e-06

2.5 Capacitor discharge table (4)

		Time (s)	v	v+	ln (V+)	dy	dx	dy/dx
1	2100	0.02095	3.9529	8.9529	2.191978	x	x	x
2	2222	0.02217	2.949	7.949	2.073046	-0.11893	0.00122	-97.4847
3	2444	0.02439	1.5059	6.5059	1.872709	-0.20034	0.00222	-90.2417
4	2666	0.02661	0.4392	5.4392	1.693632	-0.17908	0.00222	-80.6655
5	2888	0.02883	-0.4392	4.5608	1.517498	-0.17613	0.00222	-79.3396
6	3110	0.03105	-1.1922	3.8078	1.337052	-0.18045	0.00222	-81.2822
7	3332	0.03327	-1.7569	3.2431	1.17653	-0.16052	0.00222	-72.3072
8	3554	0.03549	-2.1961	2.8039	1.031011	-0.14552	0.00222	-65.5488
9	3776	0.03771	-2.6353	2.3647	0.860651	-0.17036	0.00222	-76.7388

2.6 Gradient Plot and calculations (4)



2.7 Capacitor Uses (5)

Energy storage in regenerative braking systems, Capacitors store the energy generated during regenerative braking, which is then used to power auxiliary systems or assist in acceleration.

Filtering and smoothing voltage, Capacitors are used in conjunction with rectifiers to smooth out voltage fluctuations and filter out noise in electrical system.

Power factor correction, Capacitors are employed to improve the power factor in electrical systems, ensuring efficient power transfer and reducing energy losses.

DC link capacitors in inverters, In electric vehicle inverters, capacitors serve as DC link capacitors, storing and supplying energy to smooth out DC bus voltage variations.

Suppressing electrical noise, In electric vehicle inverters, capacitors serve as DC link capacitors, storing and supplying energy to smooth out DC bus voltage variations.

Voltage regulation in power electronics, In electric vehicle inverters, capacitors serve as DC link capacitors, storing and supplying energy to smooth out DC bus voltage variations.

Transient voltage suppression, Capacitors protect sensitive electronic components from voltage spikes and transient surges, enhancing the reliability and longevity of electrical systems in vehicles.

Timing circuits in ignition systems, Capacitors are utilized in timing circuits within ignition systems of internal combustion engine vehicles, helping regulate the timing of spark plugs for optimal engine performance.

Electric motor start capacitors, In motorcycles with electric starters, capacitors are used as start capacitors to provide the initial boost of power needed to start the motor quickly and efficiently.

Voltage stabilization for LED lighting systems, In automotive and motorcycle lighting systems, capacitors stabilize voltage fluctuations, ensuring consistent brightness and longevity of LED lights.

(Andrew wilson, 2022)

2.8 Inaccuracies Question (4)

The sampling rate of an oscilloscope determines how frequently it samples the input signal. If the sampling rate is too low relative to the frequency of the signal being measured, aliasing can occur, leading to inaccuracies in the displayed waveform.

The probe and cables used with the oscilloscope can introduce impedance mismatches or noise, affecting the accuracy of the measurement.

Broken or damaged wires will cause there to be inaccuracies in the readings the oscilloscope produces these can be visual breaks in the cables or even internal non-visual breaks.

Oscilloscopes need periodic calibration to ensure accurate measurements. If not calibrated correctly or regularly, measurement errors may occur.

Environmental noise or noise generated within the oscilloscope itself can affect the accuracy of measurements, especially for low-level signals.

Cheap quality equipment will lead to the data not being read as accurately and better quality equipment.

Having poor connections onto the circuit that is being read will affect the data produced for example the probe not having a solid connection onto the terminal.

(Herrres, 2017)

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