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Electronic Circuits Testing and Application

Electrical Control Systems

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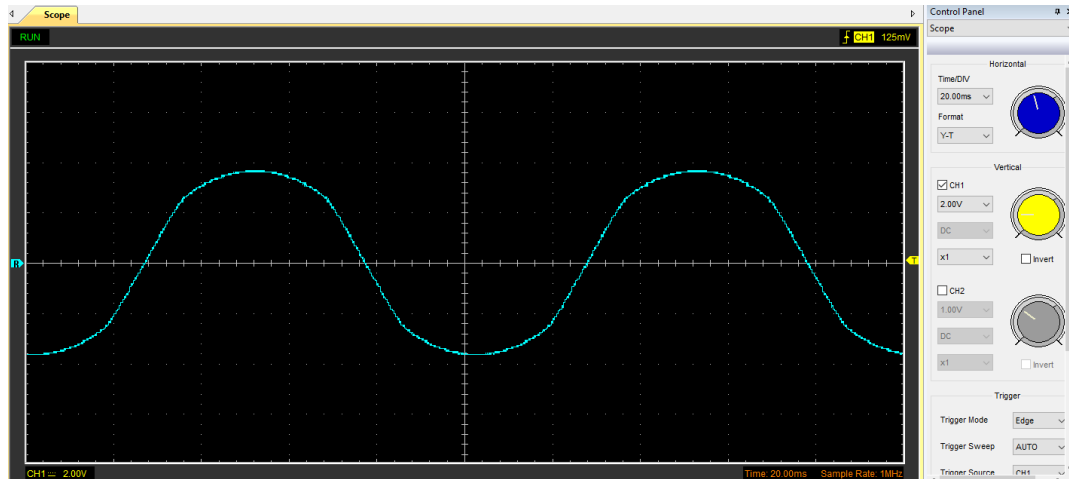
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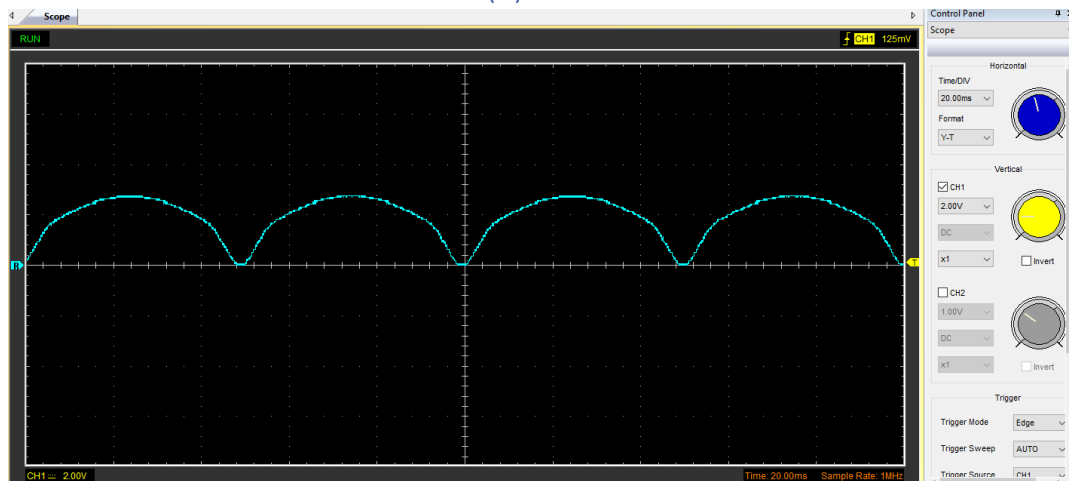
1 Task 2

1.1 Scope Time Division Calculations (4)

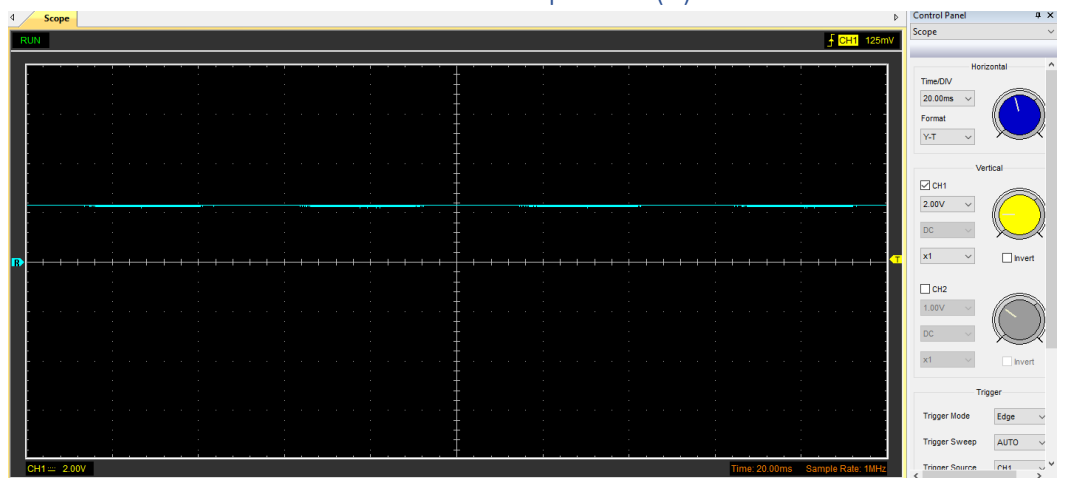
1.2 Function Generator output sine wave (3)



1.3 Unsmoothed Rectifier Wave (3)



1.4 Smoothed Rectifier Wave with capacitor (3)



1.5 Drop in Voltage Question (4)

A rectifier converting AC to DC can result in a lower DC output voltage than the peak voltage of the AC input due to several factors:

- Diode Voltage Drop: Diodes conducting current in one direction have a forward voltage drop across them, reducing the output voltage.
- Transformer Voltage Ratio: If a transformer is used in the circuit, the output voltage will be lower than the peak of the input sine wave if the turns ratio is less than unity.
- Filtering Components: Capacitors used in rectifier circuits to smooth out the pulsating DC output can cause voltage drops due to the voltage drop across the diodes and the voltage ripple caused by the capacitor charging and discharging.

1.6 Different Voltage Readings Question (5)

The Root Mean Square (RMS) is a statistical measure that calculates the average value of a varying quantity, especially in the context of alternating current AC electricity (Onajite 2014). It is determined by taking the square root of the mean average of the squares of the values.

In the context of AC electricity, the RMS value represents the effective or equivalent DC voltage or current that would generate the same amount of power dissipation in a resistive load as the AC waveform being measured.

1.7 Rectifiers use in Automotive applications Question. (4)

Rectification is the process of converting alternating current AC to direct current DC (ROHM 2021). This process is essential in various vehicle systems, including cars, motorcycles, and aeroplanes. Below are some common uses of rectification in different vehicles and their importance:

Automotive Charging Systems:

In cars, rectification is crucial in the charging system, specifically the alternator. As the engine runs, the alternator generates AC electricity through electromagnetic induction. However, the vehicle's electrical system operates in DC. Rectifiers convert the alternator's AC output into DC to charge the battery and power the vehicle's electrical components (HACW 2022).

Importance: Reliable rectification ensures that the battery remains charged and the electrical systems operate effectively, including crucial components such as the ignition system, lights, climate control, and infotainment systems.

Motorcycle Charging Systems:

Similar to cars, motorcycles also use alternators to generate AC electricity. However, rectifiers are necessary to convert this AC output into DC, which charges the battery and powers the motorcycle's electrical components (EU 2024).

Importance: Effective rectification is vital for maintaining battery charge, ensuring proper operation of essential motorcycle systems, and providing power for accessories like lights, indicators, and electronic displays.

1.8 Probing Question (4)

When trying to measure both the input of a function generator and the output of a rectifier using separate channels of an oscilloscope, it is crucial to avoid creating ground loops or shorting the signals together (Cadance Solutions 2023). This can happen for a few reasons, such as when both the input and output share a common ground reference or if standard probes with a ground connection are used.

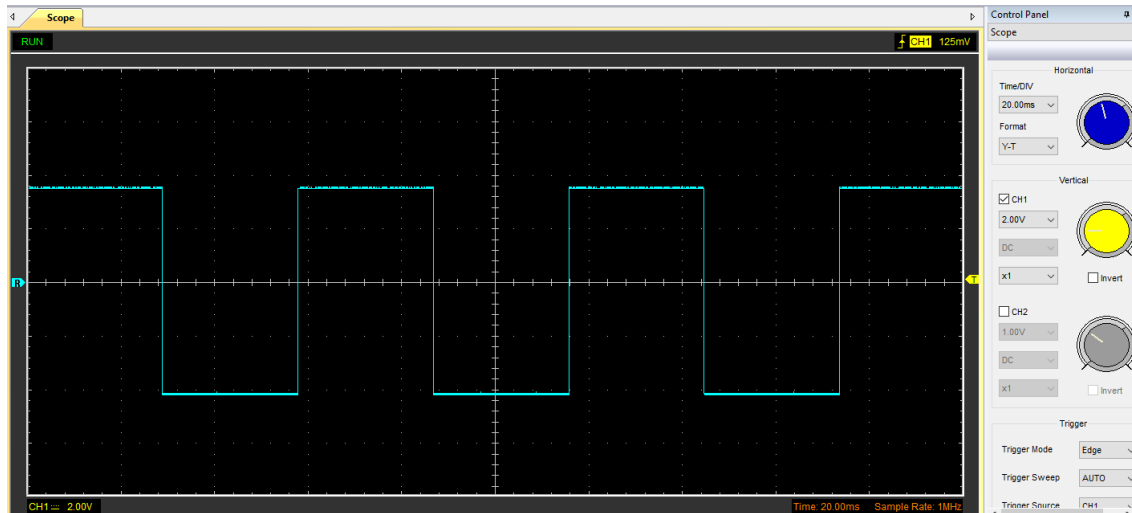
Using isolated oscilloscope probes is a solution to this problem. Isolated probes provide electrical isolation between the probe tip and the oscilloscope ground reference, allowing for simultaneous signal measurements with different ground references (Tektronix 2024). This avoids any ground loop issues or risk of shorting the signals together and helps to ensure accurate measurements without damaging the circuit or the oscilloscope.

Isolated probes usually come with differential inputs, which allow you to measure the voltage between two points without requiring a ground connection (Tektronix 2023). This feature enables you to simultaneously probe signals with different ground references while maintaining accurate measurements. Furthermore, it eliminates the risk of damaging the circuit or the oscilloscope.

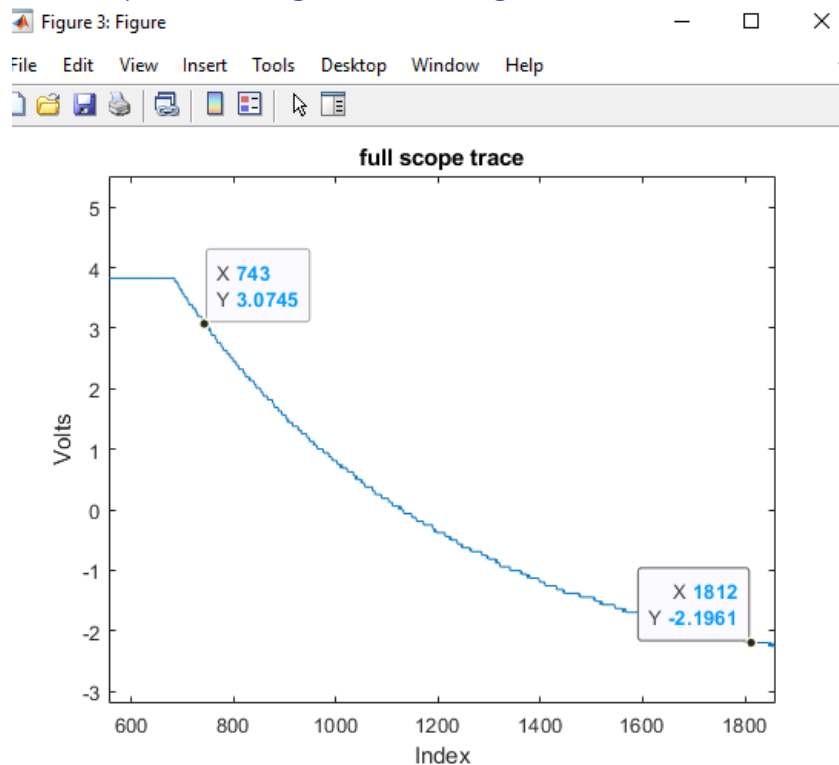
2 Task 3

2.1 Scope Time Division Calculations (4)

Function Generator output square wave (3)



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



2.3 Basic Capacitor Calculations (3)

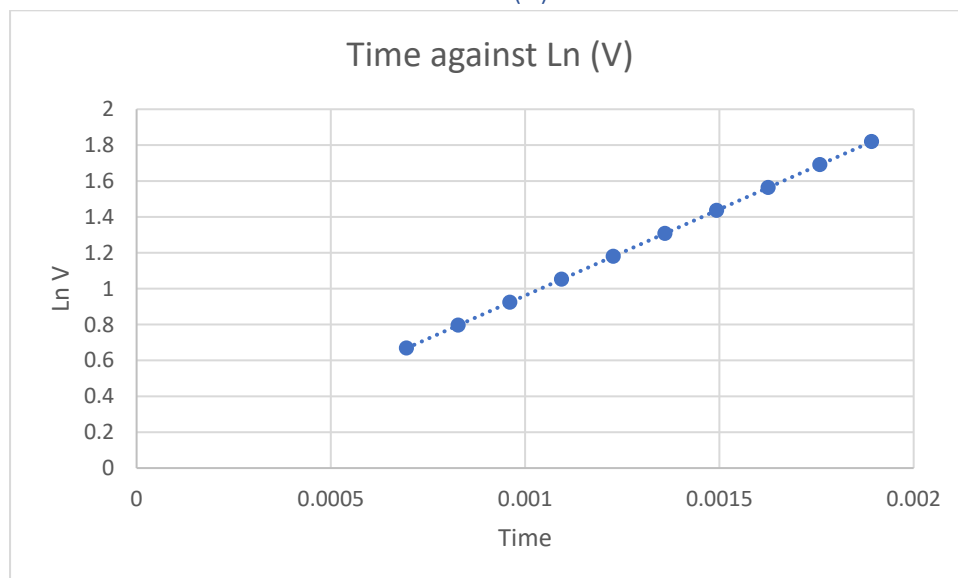
$$t = R \times C = 106 \times 100,000 = 10,600,000$$

$$1/12t = 0.00000000786$$

2.4 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
0.000695	3.5765	0.668269	x	x	x
0.000828	2.1333	0.796154			
0.000961	1.0039	0.924038			
0.001094	0.1882	1.051923			
0.001227	-0.502	1.179808			
0.00136	-1.0667	1.307692			
0.001493	-1.4431	1.435577			
0.001626	-1.8196	1.563462			
0.001759	-2.1333	1.691346			
0.001892	-2.3216	1.819231			

2.5 Gradient Plot and calculations (4)



2.6 Capacitor Uses (5)

- **Ignition Systems:** In vehicles, capacitors in ignition systems store and discharge electrical energy to create a spark for igniting fuel in the combustion chambers of engines.
- **Voltage Stabilization:** Capacitors are used in automotive and motorcycle electrical systems to stabilize voltage fluctuations, ensuring a consistent power supply to various components such as lights, sensors, and entertainment systems.
- **Audio Systems:** Capacitors in vehicles' audio systems filter out unwanted frequencies for clear sound output.
- **Electronic Fuel Injection:** Capacitors stabilize voltage and control fuel delivery in electronic fuel injection systems used in automobiles and motorcycles.
- **Electrolytic Capacitors in Rectifier Circuits:** In motorcycles and automotive applications, electrolytic capacitors are often used in rectifier circuits to convert AC to DC for charging the battery and powering electrical components.

- **Power Factor Correction:** Capacitors are used in electrical systems to improve power factor by storing and releasing electrical energy to compensate for reactive power inductive loads, thus reducing electricity costs and improving efficiency.
- **Motor Starters:** Single-phase motors commonly use capacitors to provide the initial burst of energy needed for starting.
- **Noise Filtering:** Electrical circuits use capacitors to filter noise and stabilize voltage for consistent device operation.
- **Timing Circuits:** Capacitors such as clocks or timers are used in timing circuits to regulate oscillation frequency.
- **Energy Storage:** Capacitors are electronic components that store and release electrical charge. They are used in various applications, such as camera flash units and energy harvesting systems.

2.7 Inaccuracies Question (4)

Measurement inaccuracies can occur due to various factors inherent in the measurement process. One of the primary reasons for differences between measured and specified values is the presence of measurement errors and uncertainties. These errors can originate from multiple sources, including instrument limitations, environmental conditions, and human factors.

Instrument limitations encompass the measuring device's resolution, accuracy, and precision. Instruments may have inherent inaccuracies due to design constraints or wear and tear over time (Kimberlin 2008). Environmental conditions such as temperature, humidity, and electromagnetic interference can also influence measurement outcomes, especially in sensitive equipment.

Moreover, human factors like observation bias, manual reading errors, and improper calibration procedures can contribute to measurement discrepancies (Rabinovich 2006). Acknowledging and accounting for these inaccuracies when interpreting measurement results is essential to ensure reliable and valid conclusions.

Research into measurement and test inaccuracies shows proper calibration, instrument selection, and error analysis techniques are necessary to minimize discrepancies and enhance measurement reliability (Newton 2005). Understanding the sources of inaccuracies enables improved experimental design and data interpretation.

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