

University of Wales Trinity Saint David

Wales Institute of Science and Art



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Electrical Control Systems – Task 2

Electrical Control Systems – ACHA4010

Oliver Gillson

22124045

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1 Task 2

1.1 Scope Time Division Calculations (4)

With the function generator outputting a 10Hz AC signal equation 1 can be used to determine the time division to see one full period on the scope screen.

$$Period = \frac{1}{f} \quad \dots(1)$$

If $f = 10\text{Hz}$

$$Period = \frac{1}{10} = 0.1\text{s}$$

There are ten divisions on the oscilloscope screen, each division on the screen is one full period and equates to 0.1 second or 100ms as shown in figure 1.

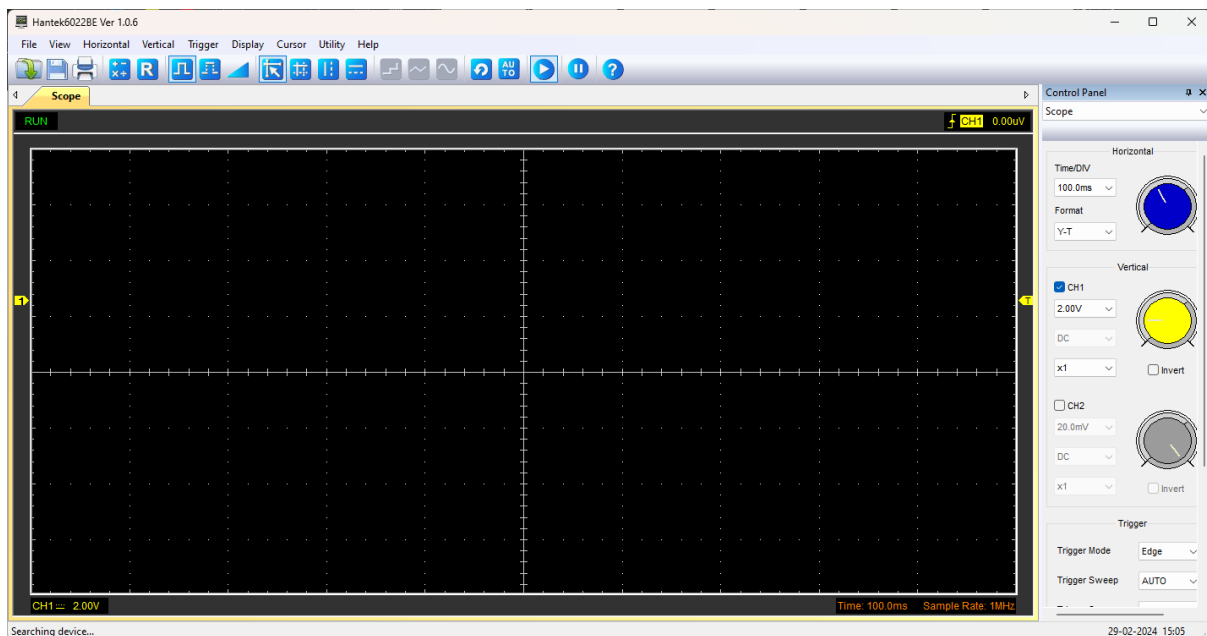


Figure 1: Scope time division showing 100ms.

1.2 Function Generator output sine wave (3)

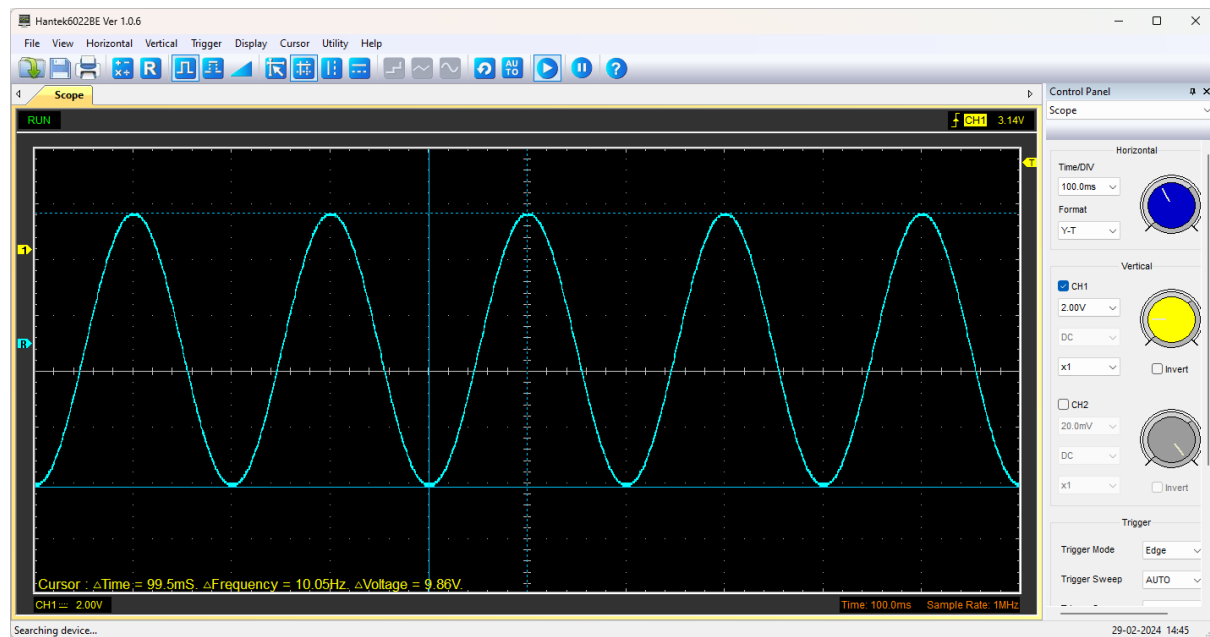


Figure 2: Function generator output.

1.3 Unsmoothed Rectifier Wave (3)

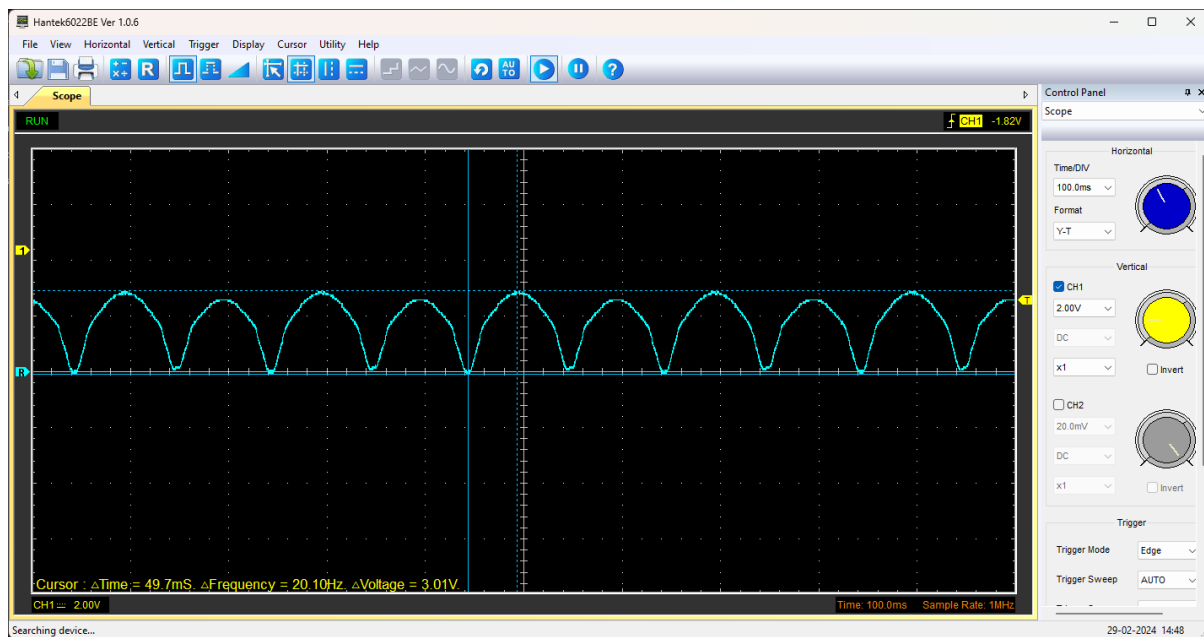


Figure 3: Rectifier without capacitor upper peak.

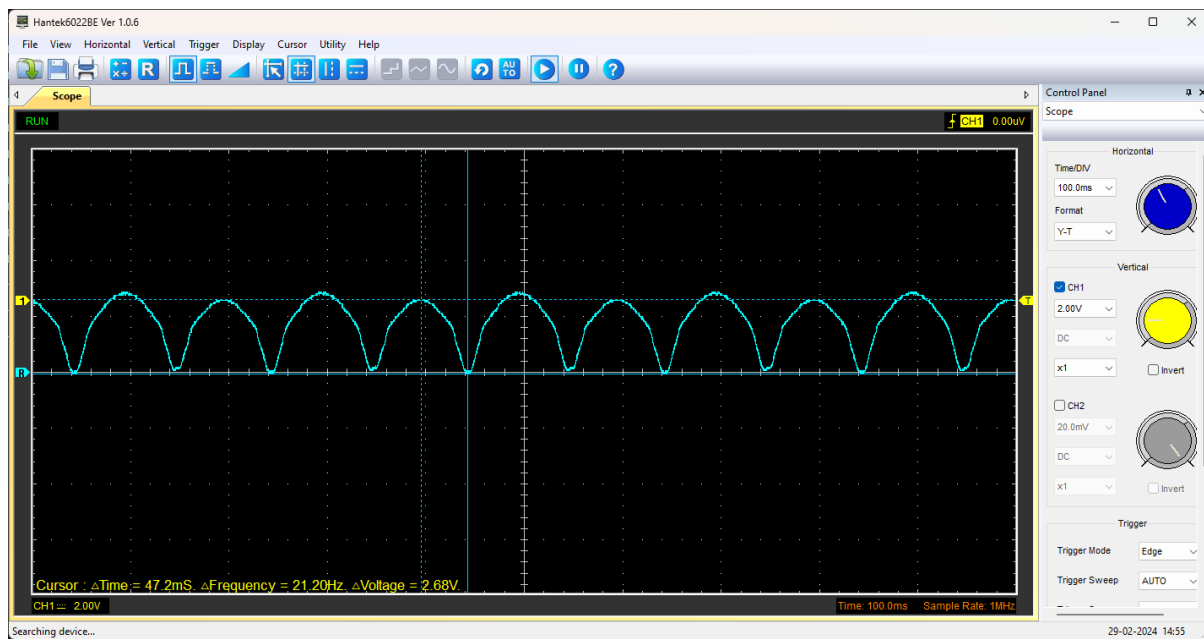


Figure 4: Rectifier without capacitor lower peak.

1.4 Smoothed Rectifier Wave with capacitor (3)

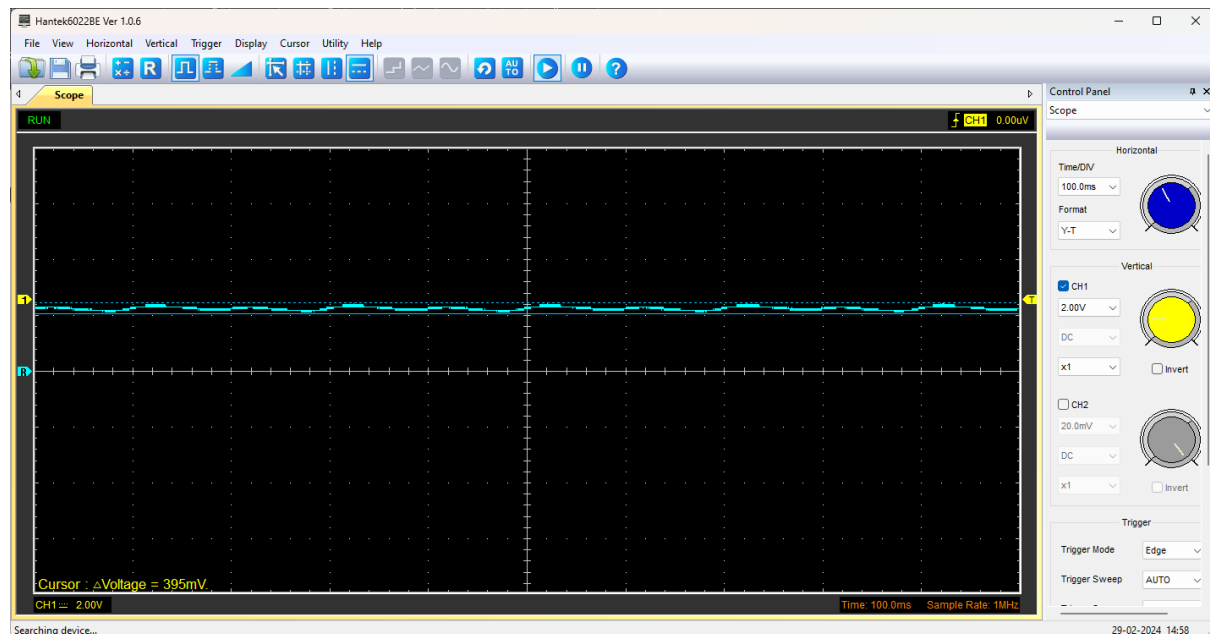


Figure 5: Rectifier with capacitor.

1.5 Drop in Voltage Question (4)

As electrons flow through resistor they lose charge, this loss of charge can be seen as a drop in voltage between the entrance and exit of the component causing resistance. The lost charge is emitted as heat or light energy, depending on the component (Floyd & Buchla, 2012 p. 102).

1.6 Different Voltage Readings Question (5)

Peak Positive Input Voltage	4.71v
Peak to Peak Voltage	9.92v
Root Mean Square (RMS)	3.33v

$$RMS = \frac{X_{peak}}{\sqrt{2}}$$

1.7 Rectifiers use in Automotive applications Question. (4)

Rectifiers are used in automotive applications to convert the alternators alternating currents into direct currents (Bosch, et al, 2007 p. 177).

The diodes in the rectifier circuit also prevent battery discharge. When stopped or at low rpm the stator is not yet excited (has not generated a magnetic field) and so without the rectifier diodes the battery voltage would flow through the stator windings. The diodes are reverse polarised to the battery voltage to prevent any discharge (Dietsche, et al, 2022 p. 1494).

1.8 Probing Question (4)

The input of a function generator and the output of a rectifier cannot be simultaneously probed with an oscilloscope due to the common ground shared by the oscilloscope channels and the function generator (University of Maryland). This common ground can cause a ground loop, which can lead to inaccurate measurements.

2 Task 3

2.1 Scope Time Division Calculations (4)

Using equation 1 (chapter 3) when $f = 15\text{hz}$.

$$\text{Period} = \frac{1}{f} = \frac{1}{15} = 0.67\text{s}$$

2.2 Function Generator output square wave (3)

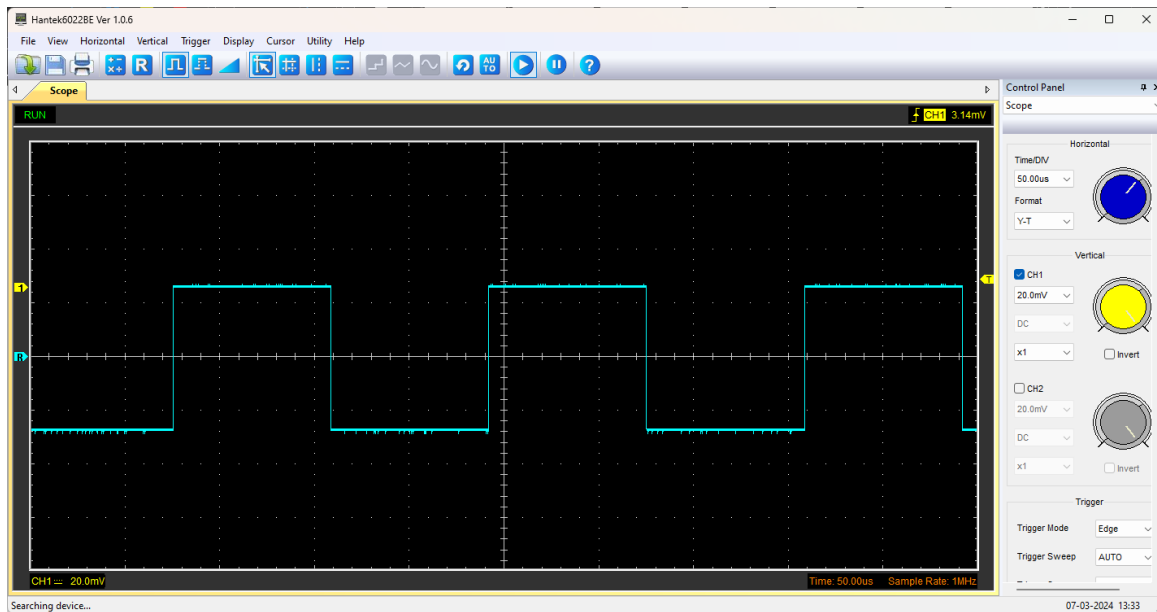


Figure 6: Function generator square wave output.

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

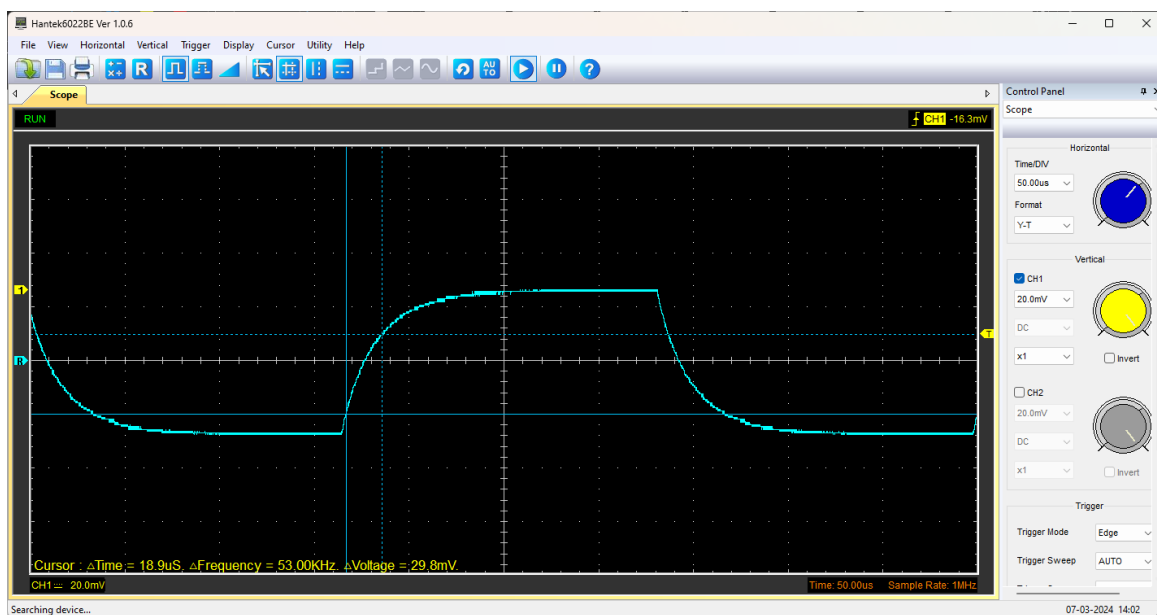


Figure 7: Capacitor charge and discharge.

2.4 Basic Capacitor Calculations (3)

$$\text{Peak Voltage} = 627\mu V$$

$$\text{Start Voltage} = -46.4mV$$

$$(\text{Peak Voltage}) - (\text{Start Voltage}) * 0.632 + (\text{Start Voltage}) = \text{Top Cursor Voltage}$$

$$(627 \times 10^{-6}) - (-46.4 \times 10^{-3}) * 0.632 + (-46.4 \times 10^{-3}) = -16.45 \times 10^{-3} mV$$

2.5 Capacitor discharge table (4)

Time (s)	Voltage (V)	Voltage (V+)	ln (V)	dy	dx	dy/dx
0.038612	0.2039	0.9039	-0.10104	x	x	x
0.038747	-0.0471	0.6529	-0.42633	1.35E-04	-0.32529	-2.41E+03
0.038883	-0.2196	0.4804	-0.73314	1.36E-04	-0.3068	-2.26E+03
0.039018	-0.3451	0.3549	-1.03592	1.35E-04	-0.30278	-2.24E+03
0.039154	-0.4235	0.2765	-1.28554	1.36E-04	-0.24963	-1.84E+03
0.039282	-0.502	0.2294	-1.47229	1.28E-04	-0.18674	-1.46E+03
0.039425	-0.5333	0.1667	-1.79156	1.43E-04	-0.31927	-2.23E+03
0.03956	-0.5804	0.1196	-2.1236	1.35E-04	-0.33204	-2.46E+03
0.039696	-0.5961	0.1039	-2.26433	1.36E-04	-0.14072	-1.03E+03

2.6 Gradient Plot and calculations (4)

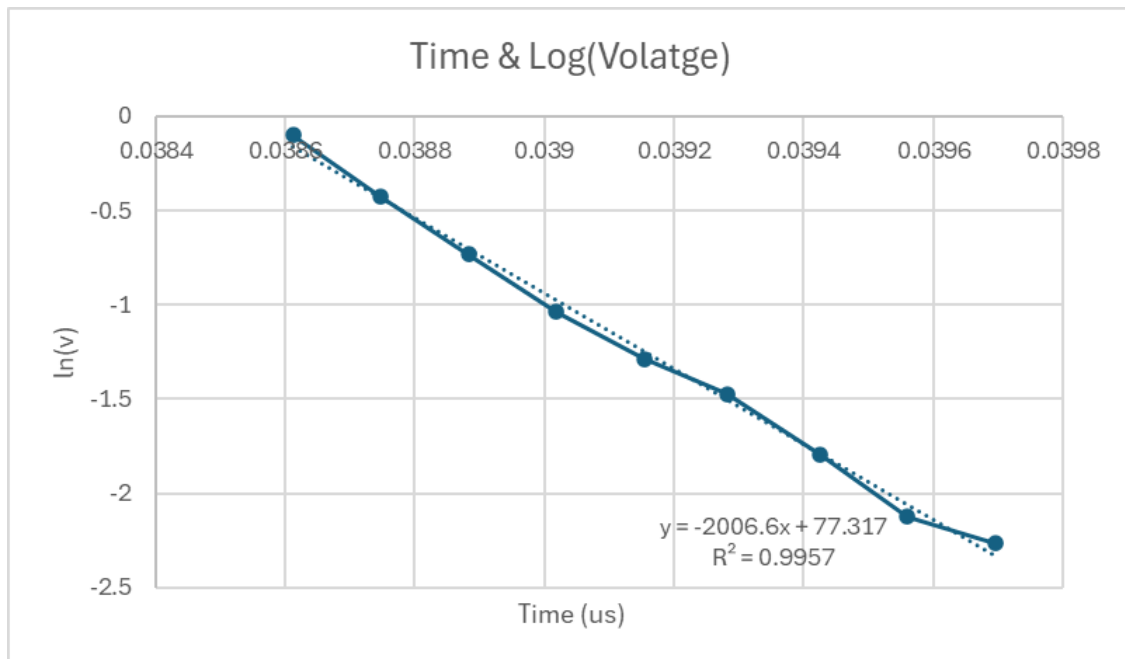


Figure 8: Time & Log of voltage.

$$\text{Average of } \frac{dy}{dx} = m = -2006.6$$

$$RC = -\frac{1}{m} = 4.98 \times 10^{-4}$$

$$\text{Resistor} = 5000\Omega$$

$$\text{Capacitance} = \frac{1}{\text{Resistance} \cdot \text{Time Constant}} = \frac{1}{5000 \cdot 4.98 \times 10^{-4}} = 0.40\mu\text{f}$$

From markings on the capacitor (684) we can determine it has a capacitance of $0.68\mu\text{f}$.

$$\text{Percentage Difference} = \frac{(\text{Known Capacitance} - \text{Found Capacitance})}{\left(\frac{\text{Known Capacitance} + \text{Found Capacitance}}{2}\right)} = \frac{(0.68 - 0.40)}{\left(\frac{0.68 + 0.40}{2}\right)} = 51.85\%$$

$$\Delta\text{Capacitance} = 0.68 - 0.40 = 0.28\mu\text{f}$$

2.7 Capacitor Uses (5)

10 uses for capacitors in electrical applications:

1. Backup voltage storage for low power circuits (Floyd & Buchla, 2012 p. 417).
2. Filter (rectifier output used to produce a constant DC voltage/power supply filter.) (Floyd & Buchla, 2012 p. 418).
3. DC Blocking (prevent DC voltage from entering an area of a circuit) (Floyd & Buchla, 2012 p. 419).
4. Power Line Decoupling (used to short voltage transients) (Floyd & Buchla, 2012 p. 421).
5. Bypassing (bypass an AC voltage around a resistor without affecting the DC voltage of the resistor) (Floyd & Buchla, 2012 p. 421).
6. Signal Filters (selecting one AC signal frequency in a range of frequencies, i.e. radio receivers or high/low pass filters on audio equipment) (Floyd & Buchla, 2012 p. 421).
7. Timing Circuits (capacitor charge time is used as a basic time delay) (Floyd & Buchla, 2012 p. 422).
8. Computer Memory (binary storage element, charged = 1, discharged = 0) (Floyd & Buchla, 2012 p. 422).
9. Capacitor Discharge Ignition (electrical energy stored in capacitor until triggered to release to primary winding coil) (Hillier & Thornes, 2014 p. 144).
10. Power-factor correction (Improve efficiency within EV chargers) (Dietsche, Reif, et al, 2022 p. 1603-4).

2.8 Inaccuracies Question (4)

Measurement and test inaccuracies can stem from a variety of sources, such as human error, instrument limitations, and environmental influences. Personal errors may occur when users make incorrect connections or misinterpret readings. Inaccuracies can arise from the instruments themselves, including the internal resistance of measuring equipment and environmental factors like temperature and humidity can also introduce errors (Professional Electrician, 2022).

3 References

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