

University of Wales Trinity Saint David

Wales Institute of Science and Art



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Electronic Circuits Testing and Applications

Electrical Control Systems ACHA4010

Rhodri Jones

2305734

17/03/25

Contents

1	Task 3	1
1.1	Scope Time Division Calculations (3)	1
1.2	Function Generator output square wave (3)	1
1.3	Capacitor charge and discharge wave marked at correct points. (3)	3
1.4	Basic Capacitor Calculations (3)	4
1.5	Capacitor discharge table (2)	5
1.6	Plot $\log(V)$ Gradient (2)	5
1.7	Gradient Calculations and Compare(4)	6
1.7.1	Gradient Calculations	6
1.7.2	Comparison table	7
1.8	Capacitor Uses (5)	8
1.9	Inaccuracies Question (4)	9
2	References	10

1 Task 3

1.1 Scope Time Division Calculations (3)

$$f = \frac{1}{\text{Period}(\tau)} \quad \& \quad \text{Period}(\tau) = \frac{1}{f} \quad \& \quad \text{DivNumberTime} = 10$$

$$f = \frac{1}{\text{Period}(\tau)}$$

$$\text{Period}(\tau) = 1/f = 1/250 = 0.004\text{ms}$$

$$\text{DivNumberTime} = 10$$

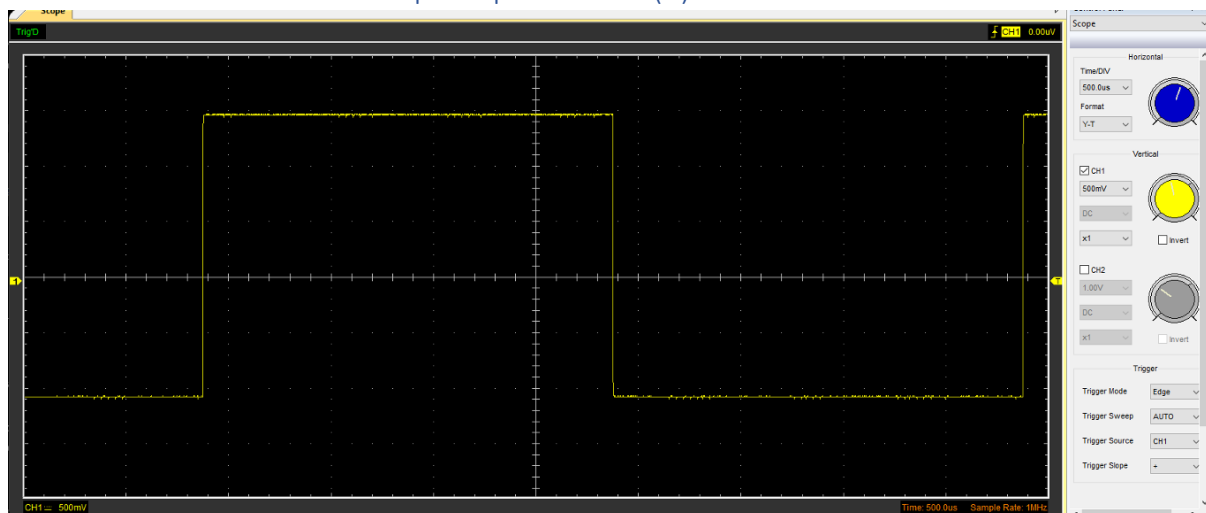
$$\tau = R * C = 100 \times 1 \times 10^{-6} = 100 \mu\text{s}$$

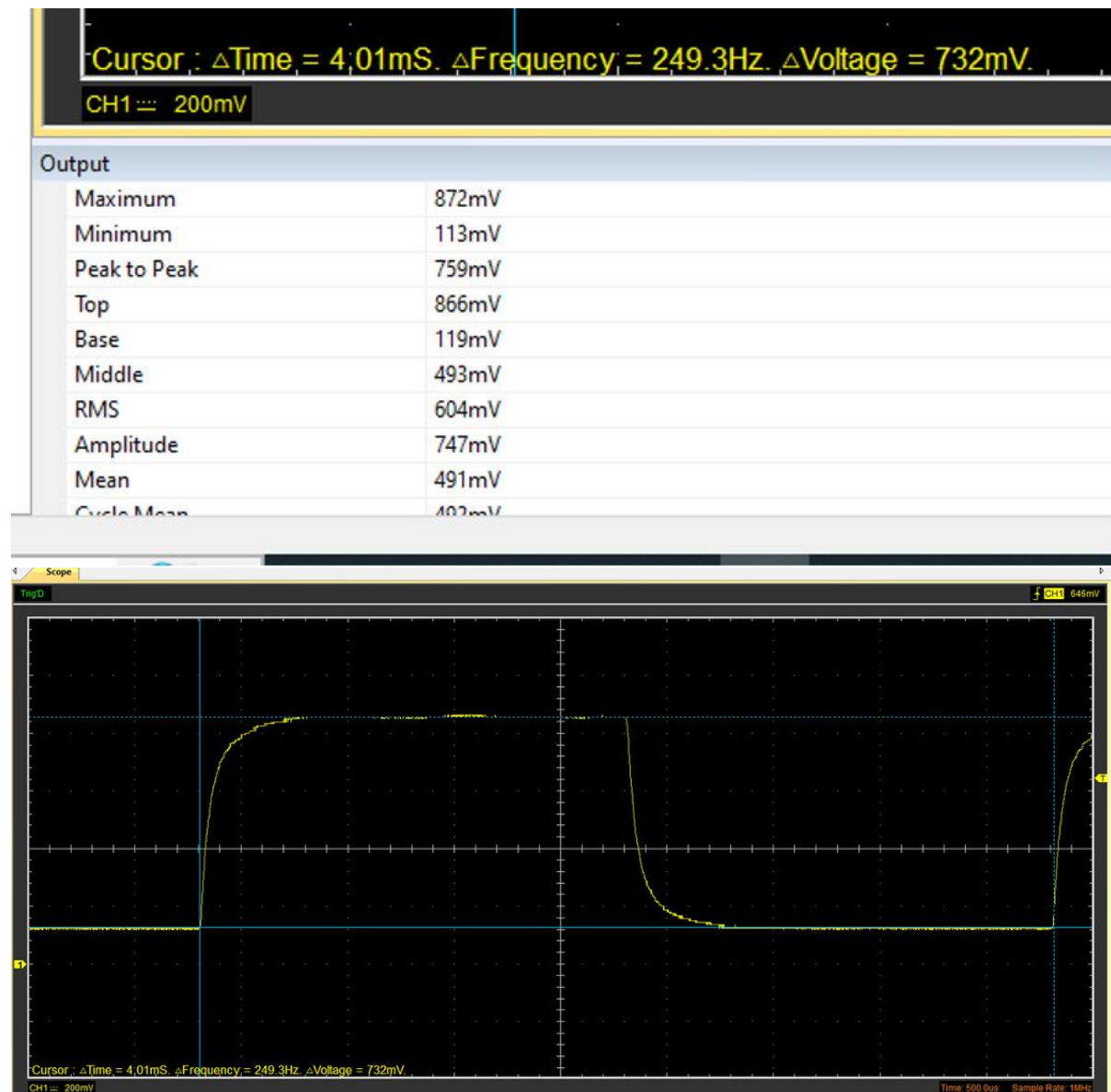
$$40\tau = 40 \times 1 \times 10^{-4} = 4\text{ms}$$

$$\text{Frequency} = 1/4 \times 10^{-3} = 250\text{Hz}$$

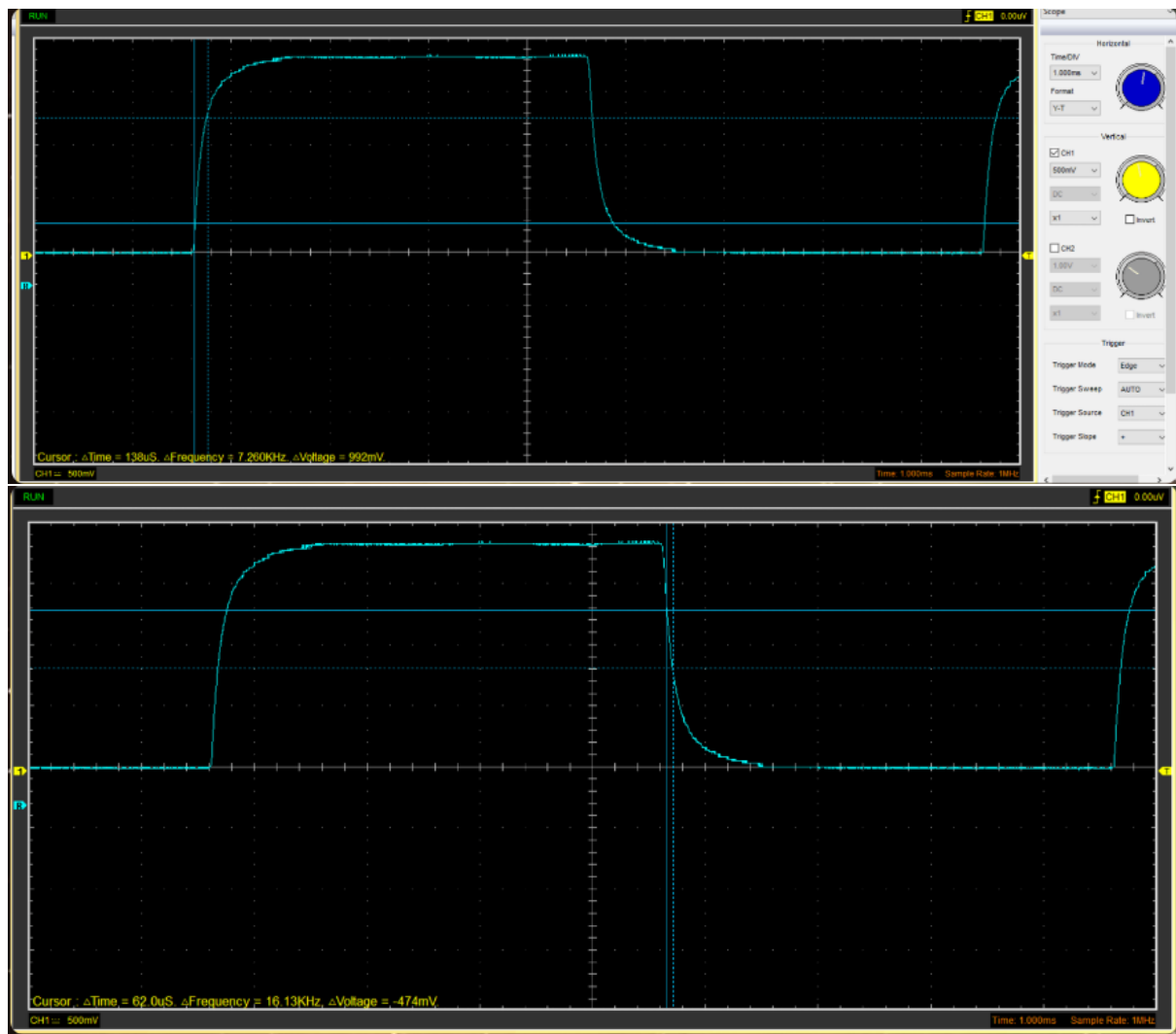
$$\text{Time per division} = 0.004/10 = 0.4\text{ms/div}$$

1.2 Function Generator output square wave (3)





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



1.4 Basic Capacitor Calculations (3)

Range of voltage = 0.27 V to 1.57 V

Time constant = Range of voltage x 0.632

Time constant = 1.57 V x 0.632 = 992mV

Time constant at capacitor wave:

Time constant = 138 μ S

Resistance = 100 Ω

Capacitance = $\frac{\text{Time Constant}}{\text{Resistance}}$

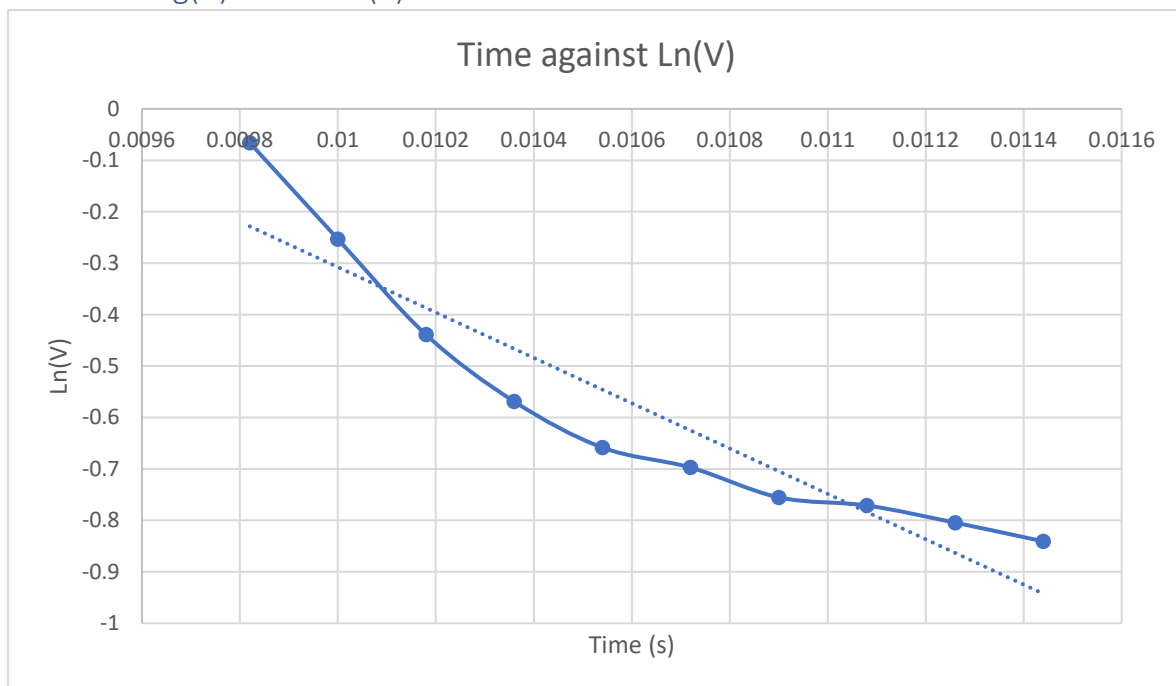
Capacitance = 138 x 10⁻⁶/11

Capacitance = 1.38 μ Farads

1.5 Capacitor discharge table (2)

Time (s)	Voltage (V)	ln (V)	$dy = y_2 - y_1$	$dx = x_2 - x_1$	dy/dx
			$dy = \ln(V)_2 - \ln(V)_1$	$dx = \text{Time}_2 - \text{Time}_1$	
0.00982	0.8596	-0.0657	x	x	x
0.01	0.5584	-0.25305	-0.187350997	0.00018	-1040.84
0.01018	0.3639	-0.43902	-0.185963354	0.00018	-1033.13
0.01036	0.2698	-0.56896	-0.12994011	0.00018	-721.89
0.01054	0.2196	-0.65837	-0.08940961	0.00018	496.72
0.01072	0.2008	-0.69724	-0.038868627	0.00018	-215.937
0.0109	0.1757	-0.75523	-0.057991947	0.00018	-322.177
0.01108	0.1694	-0.77109	-0.015858356	0.00018	-88.102
0.01126	0.1569	-0.80438	-0.033290462	0.00018	-184.947
0.01144	0.1443	-0.84073	-0.036356612	0.00018	-201.981

1.6 Plot log(V) Gradient (2)



1.7 Gradient Calculations and Compare(4)

1.7.1 Gradient Calculations

$$\text{Gradient} = y = mx + c$$

$$\text{Gradient} = \frac{dy}{dx}$$

$$dy = \ln(V)2 - \ln(V)1$$

$$dx = \text{Time}2 - \text{Time}1$$

$$y = -440.83x + 4.1$$

$$\text{Time constant} = \frac{1}{-440.83} = -0.00226844816$$

$$\text{Time constant} = 0.00227\text{s}$$

$$\text{Capacitance} = \frac{0.00226}{100}$$

$$\text{Capacitance} = 2.27 \mu\text{F}$$

1.7.2 Comparison table

	Capacitance	Delta	Percentage difference
Actual	1 μF	x	X
Marker Calculation	1.38 μF	0.38 μF	38%
Gradient Calculation	2.27 μF	0.89 μF	63.493%

$$\text{Delta} = 2.27 - 1.38 = 0.89 \mu\text{F}$$

$$\text{Percentage difference} = \left(\frac{0.89}{1.38} \right) * 100 = 64.493\%$$

1.8 Capacitor Uses (5)

- **Energy Storage**
Capacitors store energy for short-term use, such as in camera flashes or defibrillators where a sudden energy release is needed. (Horowitz and Hill, 2015).
- **Power Conditioning**
They smooth out voltage fluctuations in power supplies, helping protect sensitive components from damage. (Sedra and Smith, 2014).
- **Signal Filtering**
Used in audio and communication devices to filter out unwanted frequencies and allow desired ones through. (Storey, 2017).
- **Coupling and Decoupling**
Capacitors block DC signals while passing AC and remove AC noise from DC power lines. (Malvino and Bates, 2010).
- **Motor Starters**
Capacitors are used to start single-phase induction motors by creating a phase shift. (Hughes, 2016).
- **Timing Circuits**
In combination with resistors, capacitors are used to produce specific time delays in circuits such as oscillators and timers. (Horowitz and Hill, 2015).
- **Power Factor Correction**
In industrial electrical systems, capacitors improve energy efficiency by correcting the power factor. (Electronic Tutorials, 2023).
- **Tuning Circuits**
Capacitors are used in LC circuits for frequency tuning in radios and televisions. (All About Circuits, 2024).
- **Memory Storage**
Capacitors were used in dynamic RAM (DRAM) to store data as electrical charges. (Sedra and Smith, 2014).
- **Snubber Circuits**
Used in power electronics to suppress voltage spikes across semiconductor devices. (RS Components, 2023).

1.9 Inaccuracies Question (4)

There are several potential reasons why the measured capacitance differs from the manufacturer's stated value. Firstly, component tolerances can introduce variation — capacitors often have tolerances of $\pm 10\%$ or more (Horowitz & Hill, 2015). Environmental factors such as temperature and humidity can also affect capacitance, especially in electrolytic capacitors (Sedra & Smith, 2015).

Measurement inaccuracies may also stem from oscilloscope resolution, incorrect marker placement, or noise in the signal from the function generator. The finite rise time of the square wave can make identifying 63.2% levels imprecise, particularly at lower voltages. Additionally, breadboard and wire inductance or resistance can introduce parasitic elements altering the time constant (Paul, 2011).

Errors in the logarithmic graph method may arise from human error in recording data or curve fitting deviations. Furthermore, sampling rate limitations or low signal-to-noise ratio may distort the curve and gradient measurement.

Such factors, while small, can significantly affect calculated results in time-sensitive circuits, highlighting the importance of understanding and compensating for real-world variation in electronic systems.

2 References

All About Circuits, 2024. *Capacitor Applications*. <https://www.allaboutcircuits.com/textbook/direct-current/chpt-13/capacitor-applications/> Accessed 5/4/2025.

Electronic Tutorials, 2023. *Capacitor Uses and Applications*. https://www.electronicstutorials.ws/capacitor/cap_4.html Accessed 5/4/2025.

Horowitz, P. and Hill, W., 2015. *The Art of Electronics*. 3rd ed. Cambridge: Cambridge University Press.

Hughes, E., 2016. *Electrical and Electronic Technology*. 12th ed. Harlow: Pearson.

Malvino, A.P. and Bates, D., 2010. *Electronic Principles*. 7th ed. New York: McGraw-Hill.

RS Components, 2023. *What is a Capacitor?* <https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/what-is-a-capacitor> Accessed 5/4/2025.

Sedra, A.S. and Smith, K.C., 2014. *Microelectronic Circuits*. 7th ed. Oxford: Oxford University Press.

Storey, N., 2017. *Electronics: A Systems Approach*. 6th ed. Harlow: Pearson Education.

Paul, C.R., 2011. *Introduction to Electromagnetic Compatibility*. 2nd ed. Wiley.