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1 Task 3

1.1 Scope Time Division Calculations (3)

All equations up until 1.7.2 are sourced from 'Task 3 capacitors worksheet (James, 2025)'

$$f = 1/\text{period}(\tau)$$

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

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

$$40 \tau = 40 \cdot 1 \times 10^{-4} = 250 \text{Hz}$$

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

$$\text{Time Division squares} = 10$$

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

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

1.2 Function Generator output square wave (3)

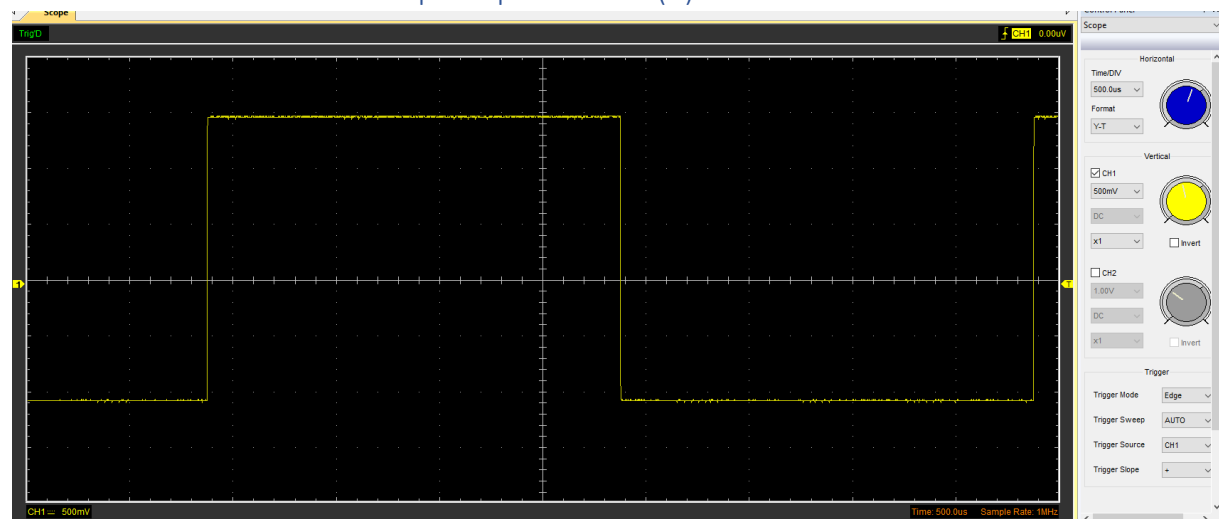


Figure 1 Function Generator Square wave (F. Flye, 2025)

Output	
CH1	
Maximum	1.54V
Minimum	-1.10V
Peak to Peak	2.64V
Top	1.54V
Base	-1.10V
Middle	220mV
RMS	1.29V
Amplitude	2.64V
Mean	222mV

Figure 2 Data from Square wave (F. Flye, 2025)

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

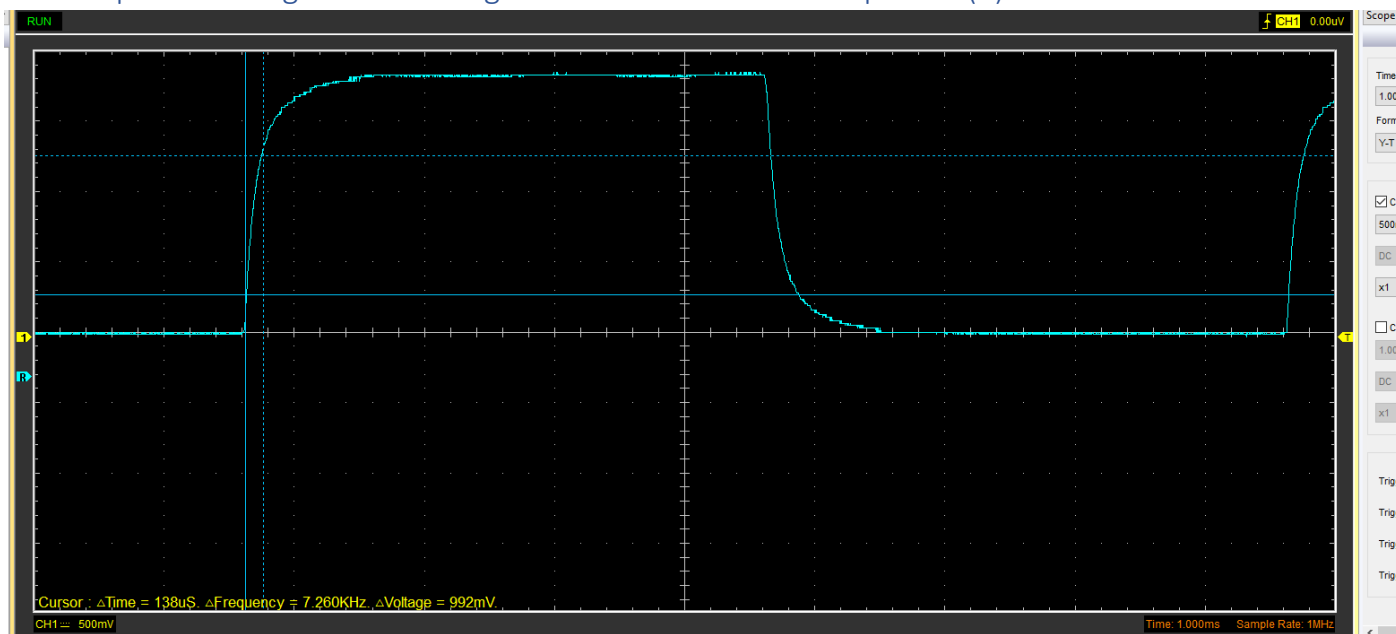


Figure 3 Capacitor wave Charge markers (F. Flye, 2025)

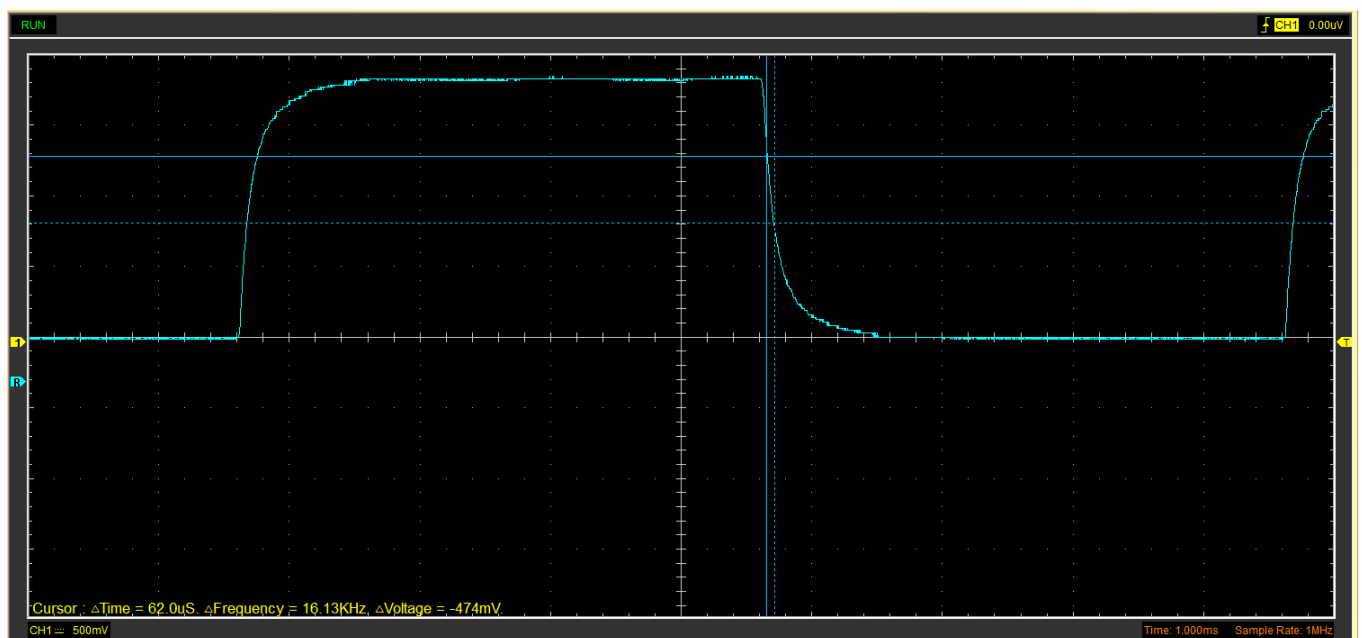


Figure 4 Capacitor wave Discharge marker (F. Flye, 2025)

1.4 Basic Capacitor Calculations (3)

Range of voltage is 0.27 to 1.57v

Time constant = Range of voltage. 0.632

Time constant = $1.57 \cdot 0.632 = 992\text{mv}$

Find value of time constant on Capacitor wave at 992mv

Time constant = $138\mu\text{S}$

Resistance = 100Ω

Capacitance = Time constant/ Resistance

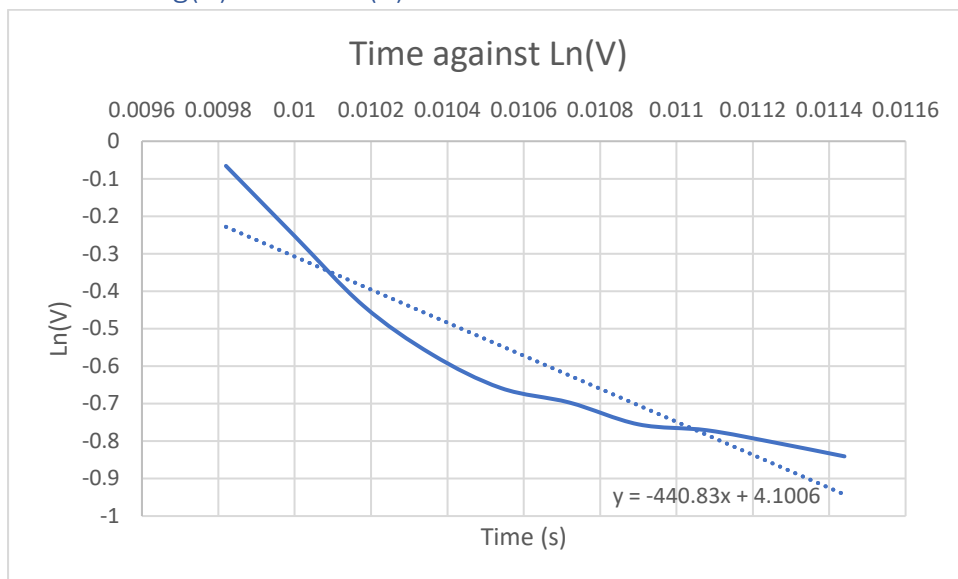
Capacitance = $138 \times 10^{-6}\text{S}/100$

Capacitance = $1.38 \times 10^{-6}\text{ Farads} = 1.38\mu\text{F}$

1.5 Capacitor discharge table (2)

Time (s)	Voltage (V)	ln (V)	dy = y2 – y1 dy = ln(V)2- ln(V)1	dx = x2- x1 dx = Time2 – Time1	dy/dx
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

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

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

$$Dy = \ln(V)_2 - \ln(V)_1$$

$$Dx = \text{Time}(2) - \text{Time}(1)$$

$$Y = -440.83x + 4.1006$$

$$\text{Time constant} = 1/(-\text{Gradient})$$

$$\text{Time constant} = 1/(-(-440.83))$$

$$\text{Time constant} = 0.002268\text{s}$$

$$\text{Capacitance} = \text{Time constant} / \text{Resistance}$$

$$\text{Capacitance} = 0.002268\text{s} / 100\Omega$$

$$\text{Capacitance} = 2.268 \times 10^{-6} \text{ Farads} = 2.268\mu\text{F}$$

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	2.268 μF	1.268 μF	126.8%

$$\Delta C = \text{Marker calculation} - \text{Actual} = 1.38 - 1 = 0.38\mu\text{F}$$

$$\Delta C = \text{Gradient Calculation} - \text{Actual} = 2.268 - 1 = 1.268\mu\text{F}$$

$$\text{Percentage difference} = \Delta C / \text{Actual} \cdot 100 = 0.38 / 1 \cdot 100 = 38\%$$

$$\text{Percentage difference} = 1.268 / 1 \cdot 100 = 126.8\%$$

1.8 Capacitor Uses (5)

Capacitors have many uses within the automotive industry from being used for lighting applications, such as a 'flasher component in a turn signal on either a car or motorcycle (Batak, 2018)', In the current day are used for 'inverter AC filtering and DC links within hybrid and electric vehicles (Montanari, Saarinen, Scagliarini, Zeidler, Niskala, Nender, 2009)', Another application of capacitors is through the use a 'packaging technique that improves electrical thermal performance (Chowdhury, Gulpinar, Ozpineci, 2022)'. Furthermore, they are used in systems that 'control the quality of power (Sarjeant, Zirnheld, MacDougall, 2002)', They are used in 'conventional spark ignition systems (Pells, 2022)'. Additionally, they are used in 'engine control units (ECU) for both gas and diesel engines and batter controls (Powers, 2015)'. Finally, they can be implemented into the 'regenerative braking system that restores the kinetic energy lost as heat by turning it into electricity when the car decelerates (Powers, 2015)'.

In the electrical industry they are used in a variety of ways to improve overall performance and stability of circuits, for example, 'Decoupling and bypassing' to stabilize power supply line and to filter out noises produced (Ahmed, 2024)', they can also be implemented into 'AC motor drives due to their ability to handle large currents (Ahmed, 2024)'. With this they can be used implemented into vehicles to 'boost the power to a lithium ion battery (Brown, 2019)'.

1.9 Inaccuracies Question (4)

The measurements may vary to those supplied due to the voltage drop across the diode as the 'depletion region forms via the P-N junction under the influence of the voltage that was applied (All About Circuits, 2022)'. There are variations in the voltage as well as the wires have 'inherent resistance to the flow of current causing slight deviations in the voltage (IEWC, 2025)'. Thus, causing lower value in voltage which in turn will give deviations to the values of capacitance calculated from both marker and gradient calculations. For the marker calculations the results could have varied due to the leads and 'probes for the oscilloscope could have been damaged so that the connection was poor giving an inaccurate waves (Harris, 2024)'.

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