Lab Experiment #7:

Oscilloscope

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Data

Scope setup

Timebase (s/ div)	T (div)	T (s)	Chan. 1 scale (V\ div)	V_m (div)	V_m (V)
$1\,\frac{\text{ms}}{\text{div}}$	0.6 div	$0.6 \times 10^{-}3$ s	$1\,\frac{\text{V}}{\text{div}}$	2 div	2 V
$0.5\,\frac{\text{ms}}{\text{div}}$	1.25 div	$0.625 \times 10^{-}3$ s	$1\,\frac{\text{V}}{\text{div}}$	2 div	2 V
$0.1\,\frac{\text{ms}}{\text{div}}$	6.3 div	$0.63 \times 10^{-}3$ s	$1\,\frac{\text{V}}{\text{div}}$	2 div	2 V
$0.1\,\frac{\text{ms}}{\text{div}}$	6.4 div	$0.64 \times 10^{-}3$ s	$2\,\frac{\text{V}}{\text{div}}$	1 div	2 V
$0.1\,\frac{\text{ms}}{\text{div}}$	6.35 div	$0.635 \times 10^{-}3$ s	$0.5\,\frac{\text{V}}{\text{div}}$	4 div	2 V

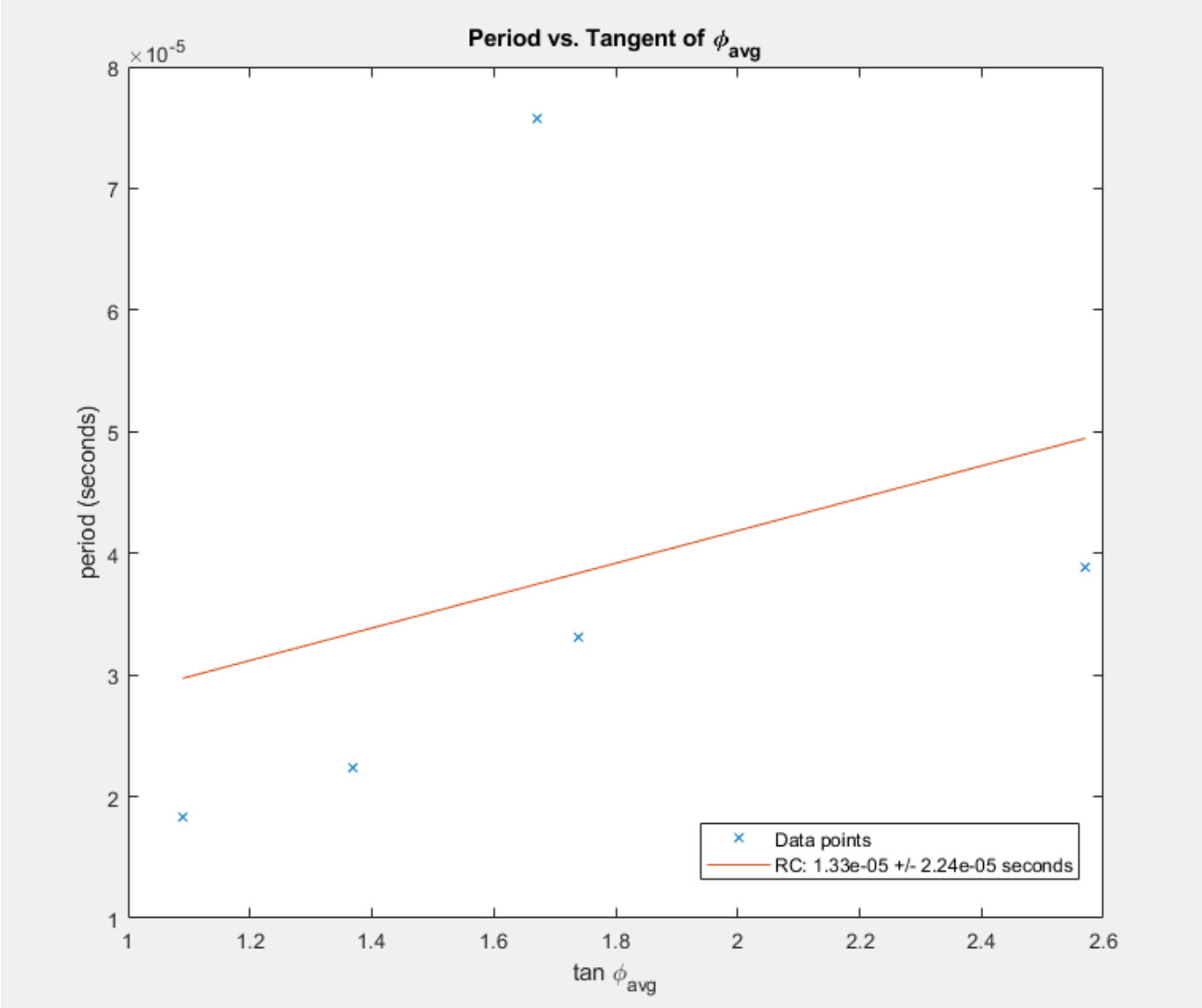
The values of the period T compared to the voltage V remain fairly constant: there is no significant quantitative change in voltage vs. time as the scale definitions are changed.

Circuit measurements

Set frequency f_s	ΔT	T	$V_{m,\,bc}$ (div)	$V_{m,\,ac}$ (V)
1000 Hz	$0.25\ \text{div} \times 0.0002\,\frac{\text{s}}{\text{div}} = 5 \times 10^{-5}\ \text{s}$	$4.8\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 4.8 \times 10^{-4}\ \text{s}$	$0.8\ \text{div} \times 0.5\,\frac{\text{V}}{\text{div}} = 0.4\ \text{V}$	$2\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 2\ \text{V}$
2000 Hz	$0.4\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 4 \times 10^{-5}\ \text{s}$	$2.4\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 2.4 \times 10^{-4}\ \text{s}$	$0.6\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 0.6\ \text{V}$	$2\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 2\ \text{V}$
3000 Hz	$0.3\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 3 \times 10^{-5}\ \text{s}$	$2.1\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 2.1 \times 10^{-4}\ \text{s}$	$0.7\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 0.7\ \text{V}$	$2\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 2\ \text{V}$
4000 Hz	$0.3\ \text{div} \times 50\,\frac{\mu\text{s}}{\text{div}} = 1.5 \times 10^{-5}\ \text{s}$	$1.4\ \text{div} \times 0.1\,\frac{\text{ms}}{\text{div}} = 1.4 \times 10^{-4}\ \text{s}$	$0.8\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 0.8\ \text{V}$	$2\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 2\ \text{V}$
5000 Hz	$0.2\ \text{div} \times 50\,\frac{\mu\text{s}}{\text{div}} = 1 \times 10^{-5}\ \text{s}$	$2.3\ \text{div} \times 0.1\,\frac{\mu\text{s}}{\text{div}} = 1.15 \times 10^{-4}\ \text{s}$	$0.9\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 0.9\ \text{V}$	$2\ \text{div} \times 1\,\frac{\text{V}}{\text{div}} = 2\ \text{V}$

Calculations

Set frequency f_s	f_{exp} (Hz)	ϕ_1 (rad)	ϕ_2 (rad)	ϕ_{avg} (rad)	tan ϕ_{avg}
1000 Hz	2100Hz	1.4 rad	0.65 rad	1.03 rad	1.67
2000 Hz	4100Hz	1.3 rad	1.1 rad	1.2 rad	2.57
3000 Hz	4800Hz	1.2 rad	0.90 rad	1.05 rad	1.74
4000 Hz	7100Hz	1.2 rad	0.67 rad	0.94 rad	1.37
5000 Hz	8700Hz	1.1 rad	0.55 rad	0.83 rad	1.09



From slope: $RC = 1.33 \times 10^{-5}$ seconds

From given values: $RC = 5.94 \times 10^{-5}$ seconds

Data sheet + Quiz

7.9 Data sheet

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Data

Scope setup (7.6.1)

Timebase (s/DIV)	T (DIV)	T (s)	Ch1 scale (V/DIV)	V_m (DIV)	V_m (V)
1 ms/DIV	0.6 DIV	0.6×10^{-3} s	1 V/DIV	2 DIV	2V
.5 ms/DIV	1.25 DIV	0.625×10^{-3} s	1 V/DIV	2 DIV	2V
.1 ms/DIV	6.3 DIV	0.63×10^{-3} s	1 V/DIV	2 DIV	2V
.1 ms/DIV	6.4 DIV	0.64×10^{-3} s	2 V/DIV	1 DIV	2V
.1 ms/DIV	6.35 DIV	0.635×10^{-3} s	0.5 V/DIV	4 DIV	2V

Compare your five entries in $T(s)$ to each other. Compare your five entries in $V_m(V)$ to each other. How are they related? Both T(s) and V_m(V) remain fairly constant; there is no significant change in voltage vs. time as the scale of timebase or scale of V/div is varied.

Circuit measurements (7.6.2)

Enter your measurements in the form "5.0 DIV x 1.0 V/DIV = 5.0 V", see template in first entry in the table.

Set frequency f_s	ΔT	T	$V_{m,bc}$	$V_{m,ac}$
1000 Hz	.25 DIV x 2 s/DIV = 0.5 s	[illegible]	0.8 DIV x .5 V/DIV = 0.4 V	2 DIV x 1 V/DIV = 2V
2000 Hz	0.4 DIV x 0.1×10^{-3} s =	[illegible]	0.6 DIV x 1 V/DIV = 0.6	2 DIV x 1 V/DIV = 2V
3000 Hz	0.3 DIV x 0.1×10^{-3} s/div	2.1 x 1 ms/DIV	0.7 DIV x 1 V/DIV	2 DIV x 1 V/DIV = 2V
4000 Hz	0.3 DIV x 50 µs/DIV	1.4 x 0.1 ms/DIV	0.8 DIV x 1 V/DIV	2 DIV x 1 V/DIV = 2V
5000 Hz	0.2 DIV x 50 µs/DIV	2.3 x 50 µs/DIV	0.9 DIV x 1 V/DIV	2 DIV x 1 V/DIV = 2V

Calculation

Calculate the following (section 7.8-2).

Make sure that ϕ_1 and ϕ_2 are in rads and are similar numbers.

Set frequency f_s	f_{exp} (Hz)	ϕ_1 (rad)	ϕ_2 (rad)	ϕ_{av} (rad)	tan ϕ_{av}
1000 Hz	2100 Hz	1.4 rad	0.65 rad	1.03 rad	1.67
2000 Hz	4100 Hz	1.3 rad	1.1 rad	1.2 rad	2.57
3000 Hz	4800 Hz	1.2 rad	0.90 rad	1.05 rad	1.74
4000 Hz	7100 Hz	1.2 rad	0.67 rad	0.94 rad	1.37
5000 Hz	8700 Hz	1.1 rad	0.55 rad	0.83 rad	1.09

Extract the following (section 7.8-3).

From slope: $RC =$ 1.33×10^{-5} s From given values: $RC =$ 5.94×10^{-5} s

Quiz:

$f = 1/T$

1.) $(0.1 \frac{V}{div})(1.5\ div) = 0.15\ V\ max$

2.) $(2 \frac{V}{div})(1.5 div) = 3.0\ V\ max$

3.) $(2 \frac{s}{div})(7\ div) = 14\ s$

4.) $f = 1/T \rightarrow f = 1/14\ Hz$