RC Circuits Module (Basic AC Circuits)

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Purpose:

To give you some practice in dealing with AC Measurements, and to observe Fourier components of waves.

Procedure:

1) Hook up a 100k Ohm resistor across the function generator set to a sine wave input signal of 1 V_p and a frequency of 1k Hz.

Measure the RMS voltage of the output and compare to theoretical calculations.

- $V_{RMS} = \frac{V_p}{\sqrt{2}}$

Next calculate the V_{RMS} of a square wave using the following equation,

- $V_{RMS} = \sqrt{\frac{1}{T}\int_0^T [f(t)]^2\,dt}$

Repeat with a triangle wave.

2) Charging a Capacitor:

Build the Circuit shown in Fig. 3 with a 22nF capacitor and a 10k Ohm Resistor. Set the function generator to a 400 Hz square wave

with an amplitude that varies from 0 to 1.5 V. Measure the time constant, T, of the RC circuit (the time it takes for the signal to

drop 1/e of its initial value) and compare to the theoretical calculation.

3) Integrator Circuit:

Use the previous circuit with a square wave at a frequency of 7.5k Hz, sketch the input and output wave forms, and repeat with

sine and triangle waves.

4) Differentiating Circuit:

Build the circuit in Fig. 4 using a 10k Ohm Resistor and a 0.01 microFarad capacitor. Set the function generator to produce a 20 Hz

square wave, and sketch the output on the circuit. Repeat with a sine and triangle wave.

Data:

1) For part 1) with a 100k Ohm resistor across the function generator, the theoretical $V_{RMS} = 0.707$ V, and the measured $V_{RMS} = 0.711$ V.

For a square wave the theoretical $V_{RMS} = 1$ V, while the measure $V_{RMS} = 0.999$ V.

For a triangle wave the theoretical $V_{RMS} = 0.577$ V, and a measured $V_{RMS} = 0.574$ V.

2) After building the circuit as described in Fig. 3 the time it took for the signal to drop 1/e was approximately measured, and the theoretical calculations of this time constant calculated and compared.

- $V_{out} = \frac{\frac{1}{iwc}}{R + \frac{1}{iwc}}(V_{in})$, $z = \frac{1}{iwc}$, $T = z(c)$

$T_{measured} = 2.4 \text{ x } 10^{-4}$s

$T_{calc.} = 2.2 \text{ x } 10^{-4}$s

3) While measuring around the capacitor it is clear that the circuit yields an integrated version of the input signal, for an example the sine wave output signal is similar to the function x^2 at intervals, but before integrating the input signal has a changing linear slope(triangle). Similarly the triangle wave output has a linear slope coming from a square wave input signal. The integrating circuit works just fine.

4) From Fig. 2 it is clear that the circuit is differentiating properly by examination of the input and output signal slopes. However when the input signal is a square wave, it doesn't completely make sense. Although the derivative of a constant is zero, and the output function approaches zero after about 400 micro seconds. A sketch is shown in Fig. 5.

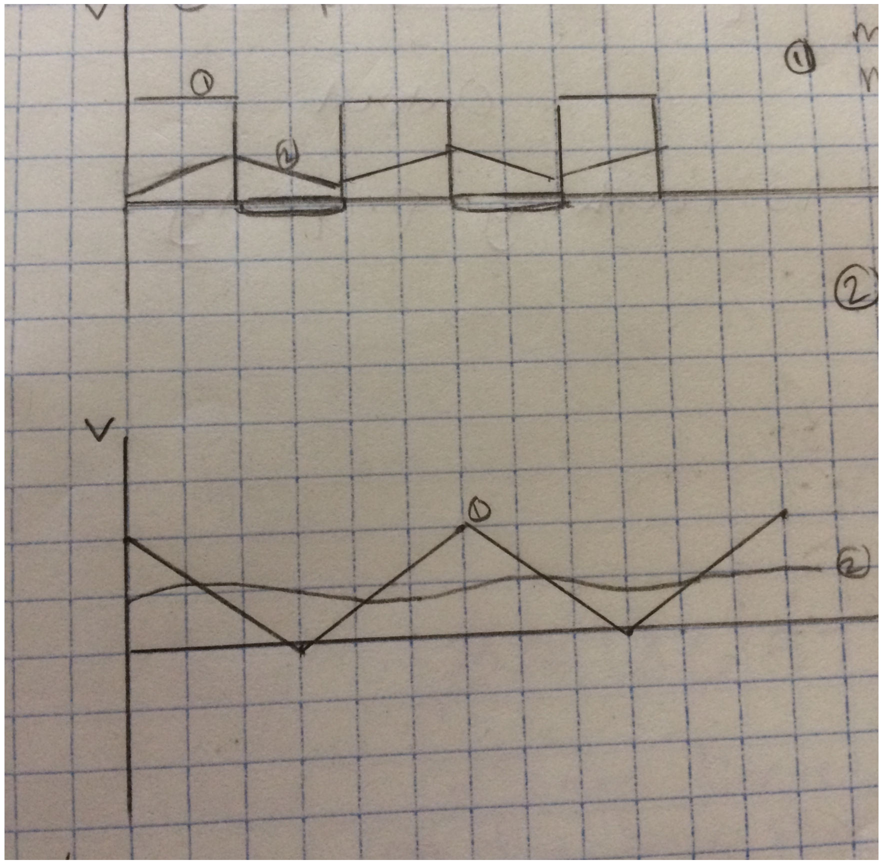

Figure 1: Integrating Circuit, 1:input sig., 2:Output Signal.

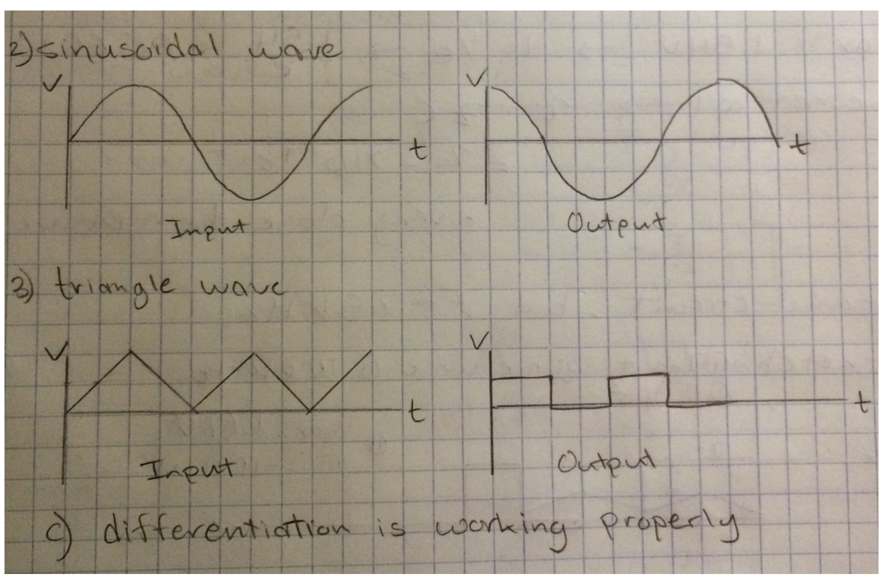

Figure 2: Differentiator Circuit Inputs and outputs.

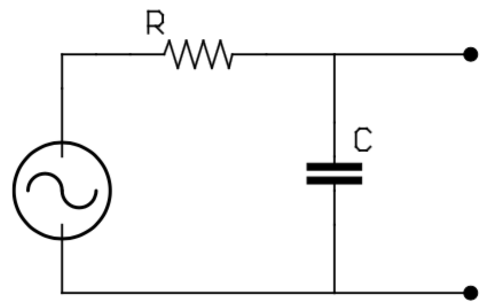

Figure 3: Basic RC Circuit/Integrator Circuit.

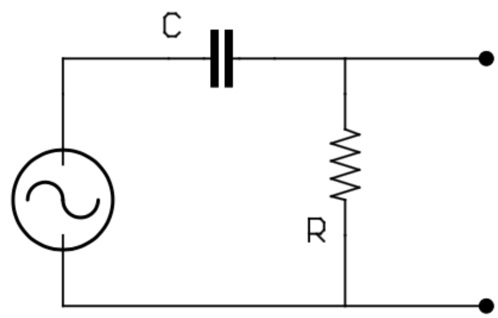

Figure 4: Differentiator Circuit

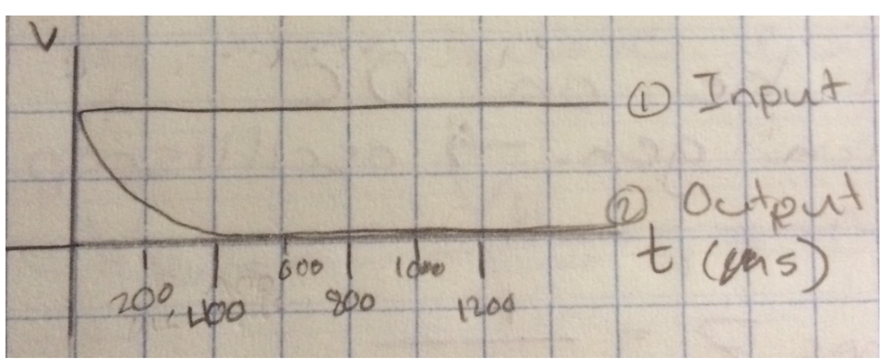

Figure 5: Input of a 20Hz square wave, with its output.