LLR.5 **15th/22nd January 2018**

Investigating diodes & rectification of an AC signal

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Introduction:

Diodes allow current to flow in only one direction in an electrical circuit, diodes are commonly used in rectification of an AC voltage to a DC voltage. We used this application in the modern world today through power lines, alternators in cars and mobile phones, within this experiment we will be using a single diode, a resistor and a capacitor to turn a AC voltage into a DC voltage, this is known as half wave rectification. LED's (Light Emitting Diodes) are used every day all over the world, it takes very little current to make them more luminesce, another more specialized diode is the Zener diode which have a well-defined breakdown of voltage in the opposite direction on the flow of current so in short Zener diodes allow current to flow in the opposite direction.

Method & Apparatus:

- Oscilloscope
- Signal Generator
- Leybold Plug-In Board
- 3x BNC Leads
- 2x Banana plugs to BNC sockets
- 470Ω, 1kΩ, 10kΩ Resistors
- 1μF, 10μF Capacitors
- 1N4007 Regular Diode
- Red & Blue LED
- 3.3v Zener diode

Following the lab script for LLR.5 we started by setting the circuit for experiment 4.1, we set the output of the signal generator to 1kHz sine wave with Vpp = 200mv across a 1kΩ resistor and measured both the input and output voltage (results below in section 4.1) we then increased the Vpp in increments of 100mv up to 2v and recorded the results (Results below in section 4.1).

Using the same circuit as experiment 4.1 we applied a Vpp = 8 across a 1kHz sine wave and saved the waveforms (see below in section 4.2). For experiment 4.2 we set up the circuit illustrated in the lab script using again 1kΩ resistor but this time adding a 1μF capacitor. In practice, the output contains residue from the original AC input, this is called periodic component. We measured the ripple percentage for this. We reduced the frequency to 500Hz and again measure the extent of the ripple, and again at 1000Hz but with different resistors (results below in section 4.2).

In experiment 4.3 we set the circuit displayed in the lab script and using a input of 1kHz sine wave we verified the LED behaves similar to the diode in experiment 4.1, we slowly increased the voltage to see when the LED started conducting and starting emitting light. After using the same circuit set up, we increased the Vpp to 20 and using the oscillations of the voltage (+/- 10v) we calculated the forward voltage of the experiment (results below in section 4.3).

Due to medical reasons, I could not complete experiment 4.4 in detail, therefore the results following are all thanks to my lab partner Ben, Ben set the circuit displayed in the lab script and using a 1kHz sine wave and 200m Vpp, monitored the input and output voltage and then he increased the voltage slowly to see which LED came on first. (results below in section 4.4).

Experiment 4.5, we returned to the circuit used in experiment 4.3 and applied 4 Vpp and again 1 kHz square wave, the red LED shined brightly, we then reduced the duty cycle of the square wave and found the duty cycle value directly affects the luminosity of the LED. Moving to experiment 4.6 with the Zener diode, we set up a new circuit using the Zener diode and using 1Vpp, 1kHz sine wave we increased the voltage 1v to 20v and measured the maximum amplitude of the voltage across the diode.

Data Collected:

Section 4.1

Input Voltage	200 (mv)	300 (mv)	400 (mv)	500 (mv)	600 (mv)	700 (mv)	800 (mv)	900 (mv)	1.0 (v)	1.1 (v)
Output Voltage (mv)	160	160	160	160	160	160	160	160	160	160
Input Voltage	1.2 (v)	1.3 (v)	1.4 (v)	1.5 (v)	1.6 (v)	1.7 (v)	1.8 (v)	1.9 (v)	2.0 (v)	
Output Voltage (mv)	320	320	320	320	400	400	480	480	560	

Section 4.2

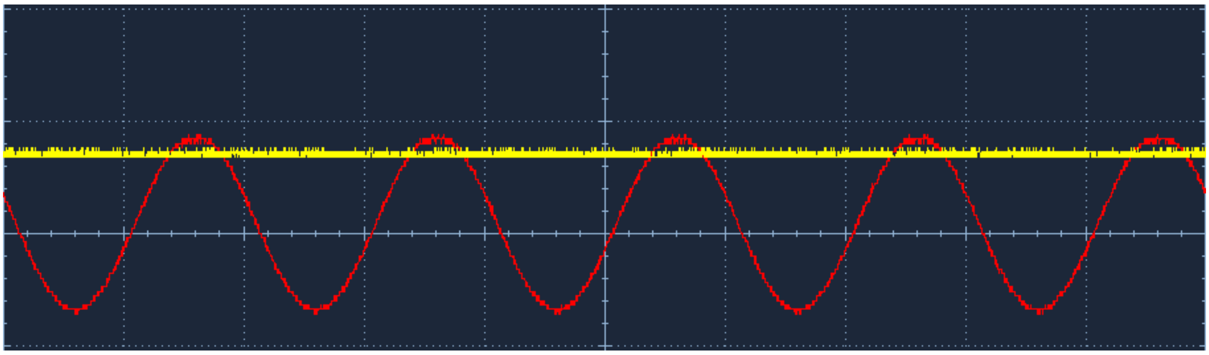
Ripple % = 100 x (1.760/2.410) = 73% @ 1kHz Sine Wave (1μF & 1kΩ)

Ripple % = 100 x (3/2.1) = 142% @ 500Hz Sine Wave (1μF & 1kΩ)

Ripple % = 100 x (400mv/2.7) = 14% @ 1kHz Sine Wave (10μF & 1kΩ)

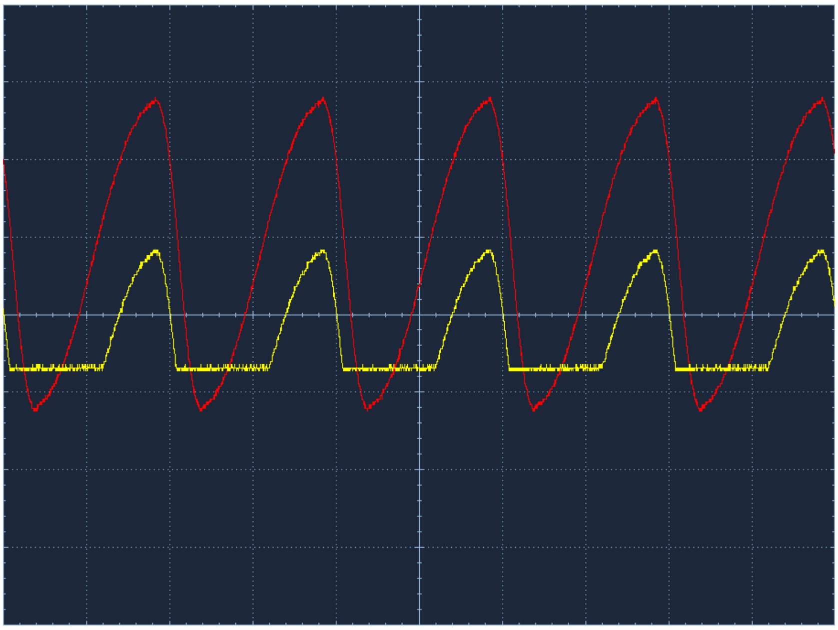
Ripple % = 100 x (600mv/3.5) = 17% @ 1kHz Sine Wave (1µF & 10kΩ)

Ripple % = 100 x (400mv/3.5) = 11% @ 1kHz Sine Wave (10µF & 10kΩ) – Least Ripple



Section 4.3

Voltage which LED begins to conduct = 400mv
Voltage which LED begins to emit light = 800mv



Waveform of voltage drop

Voltage drop = 8.2v

V for 10v = 7.6/470 = 0.0162Amps
Vf for 10v = 10 – 7.6 = 2.4v

Section 4.4

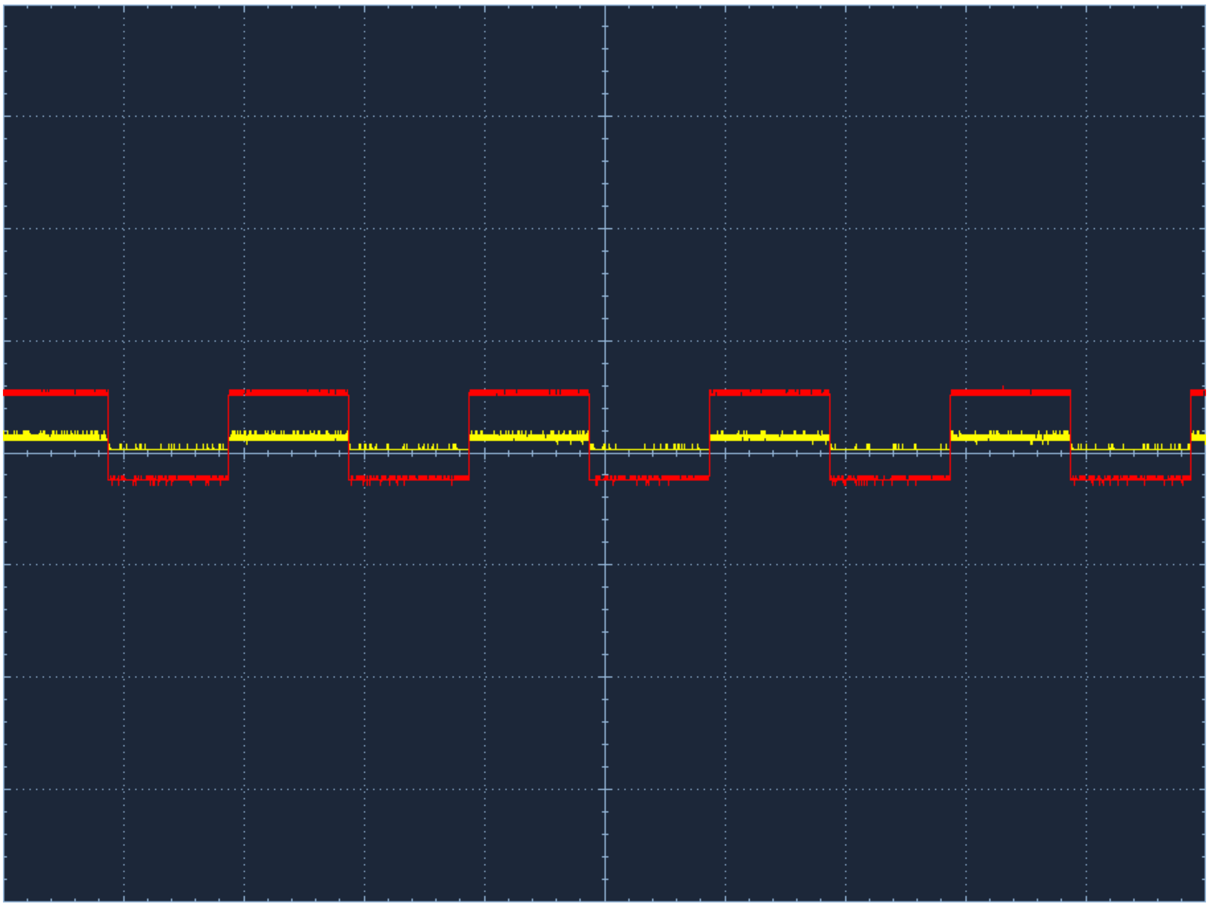
Waveform of Blue & Red Led signals

Input = 1v
Output = 1.2v

Red LED came on first at 400mv then blue at 1.2v

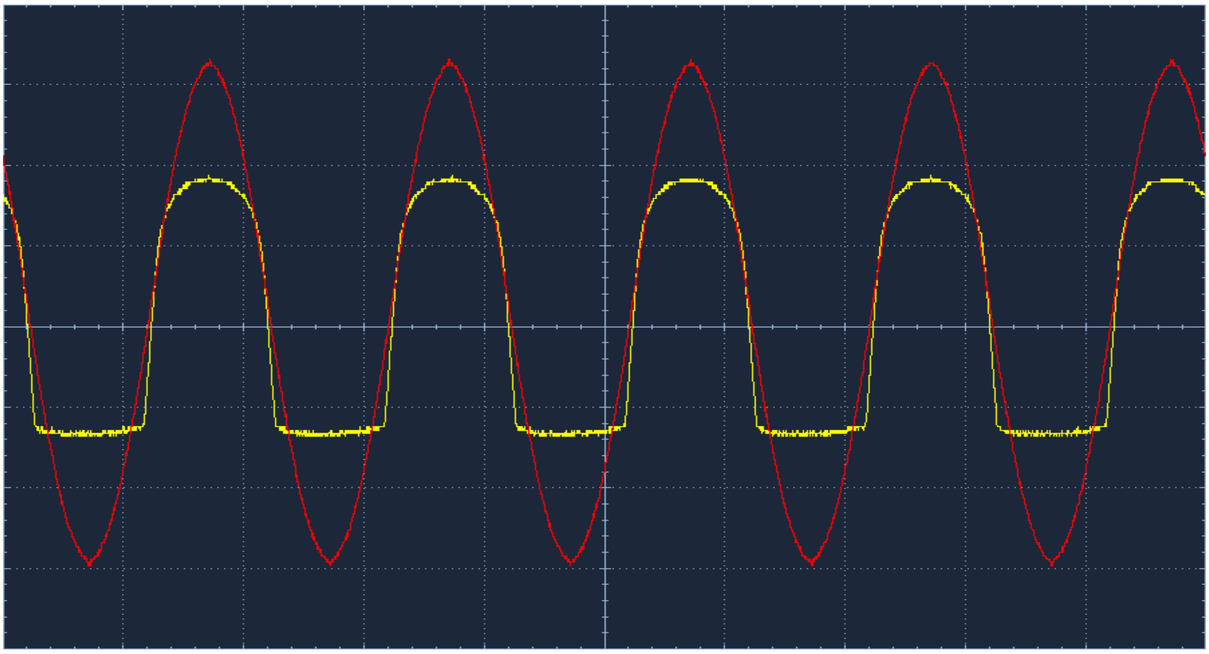
Section 4.5

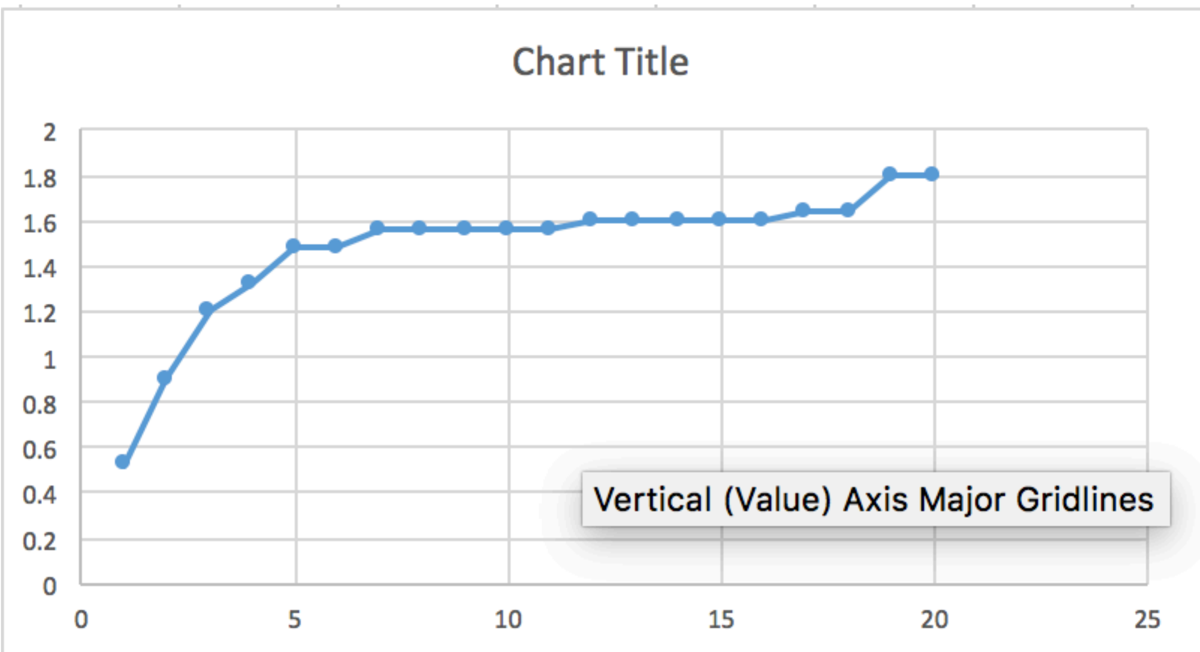
The lower the duty cycle, the dimmer the LED.



Section 4.6

Input Voltage	1(v)	2(v)	3(v)	4(v)	5(v)	6(v)	7(v)	8(v)	9(v)	10(v)
Max Voltage (mv)	520	900	1.20	1.32	1.48	1.48	1.56	1.56	1.56	1.56
Input Voltage	11(v)	12(v)	13 (v)	14 (v)	15(v)	16(v)	17(v)	18(v)	19(v)	20(v)
Max Voltage (mv)	1.56	1.60	1.60	1.60	1.60	1.60	1.64	1.64	1.80	1.80





Conclusion:

Within this experiment we have successful trialled and proven that rectification of AC voltage into DC voltage is possible through selected capacitors and resistors and is not possible in some where the resistance is to great.

References:

LLR.5 Lab Script – University Of Kent