Diodes

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March 21, 2017

Prelab Diodes

Problem 1 : Current/voltage characteristic of a diode

Question 1 and Question 2

```
y = dlmread('Prelab diodes.txt', '\t', 1, 0);
V=y(:,2);
I=y(:,3);
figure
subplot(2,1,1);
plot(V,I);
xlabel('Current');
ylabel('Volatge');
title('I versus V');
subplot(2,1,2);
semilogy(V,I);
xlabel('Current');
ylabel('Volatge');
title('log(I) versus V');
```

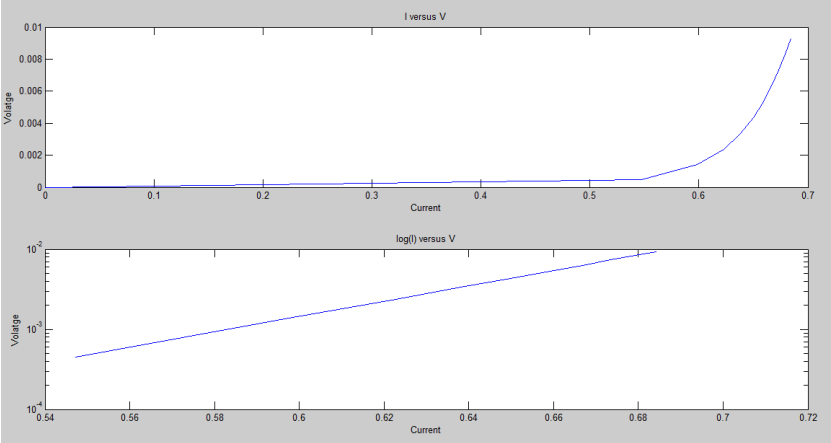


Figure 1: Top:Question one.Bottom:Question two

Question 3

$$I = I_s \exp(\frac{V}{nV_T}) \ln(I) = \ln(I_s) + \frac{V}{nV_T} V = nV_T \ln(I) - nV_T \ln(I_s) \qquad (1)$$

From the graph $nV_T = \dfrac{0.6844 - 0.5472}{\ln(0.009) - \ln(0.0005)}$ **therefore n=1.8 and** $I_s = 0.0092A$

Problem 2 Half rectifier

Question 1

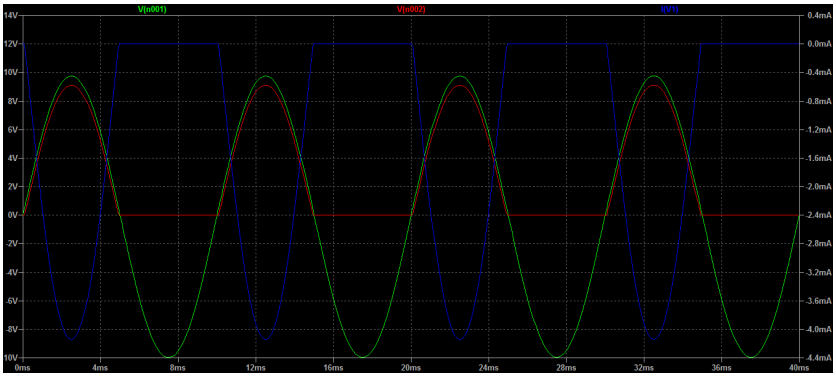


Figure 2: Green wave sinusoidal is the input voltage.Blue wave is the total current in the circuit.Red wave is the voltage across the load

Question 2

Peak voltage=9.1 V
Peak current =4.13 mA

Question 3

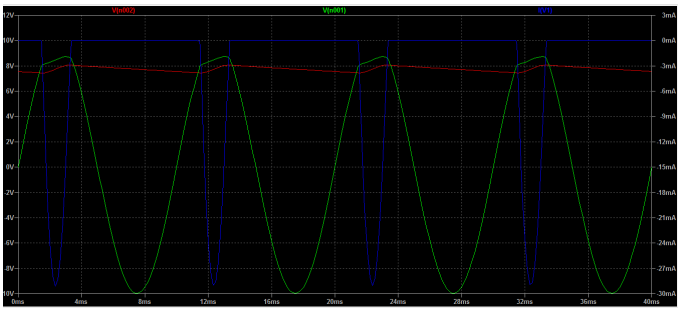


Figure 3: Green wave sinusoidal is the input voltage.Blue wave is the total current in the circuit.Red wave is the voltage across the load

Question 4

Peak current =56.07 nA
Peak Voltage=8.7V

Question 5

Using Matlab:

```
ri=50;
rl=2.2e+03;
f=100;
c=47e-06;
vp=8.7;
format long
Vr=(vp./(f.*c.*rl)).*(1-(ri./rl)^(1./4))
```

Therefore:Vr=516.2mV.The measured value is 610.4 mV.There is a large uncertainty between the measured values and the calculated values.

Problem 3:Full wave Rectifier

Question 1

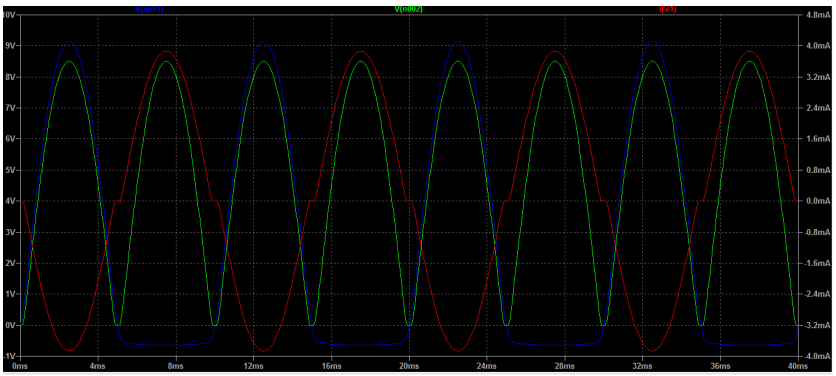


Figure 4: Blue wave sinusoidal is the input voltage.Red wave is the total current in the circuit.Green wave is the voltage across the load

Question 2

Peak voltage =9.1V
Peak Current in =3.9mA

Question 3

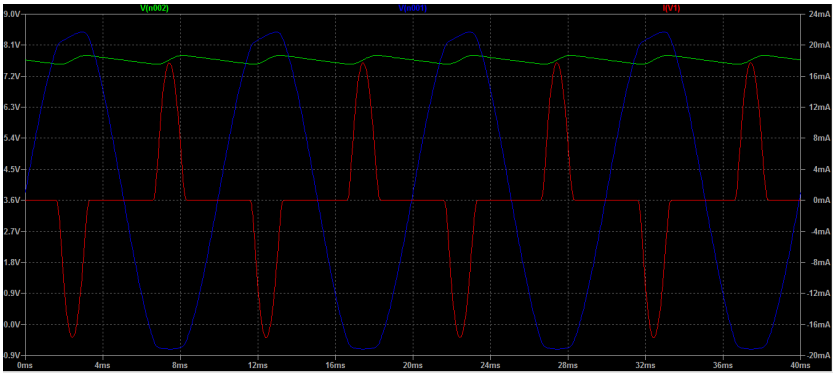


Figure 5: Blue wave sinusoidal is the input voltage.Red wave is the total current in the circuit.Green wave is the voltage across the load

Question 4

Peak voltage in =8.5V
Peak Current in UL=17.7 mA

Question 5

Using Matlab:

```
ri=50;
rl=2.2e+03;
f=100;
c=47e-06;
vp=9.14;
Vr=(vp./(2.*f.*c.*rl)).*(1-(ri./rl)^(1./4))
```

Vr=258.12 mV.
The measured value is 260.31 mV.
The measured values and calculated value have a small uncertainty.

Problem 4:Rectifier

Question 1

Rectifier	Theoretical input	Actual Input	Voltage across load
Half-Wave	10 V	8.73 V	9.10 V
Full-Wave	10 V	8.466 V	9.14 V

The maximum voltages at the load for each resistance is different from that of the input sine amplitude due the internal resistance in the voltage source internal resistance

The difference between the full wave rectifier and the half wave rectifier is that a full wave rectifier takes the absolute value of the AC voltage at the load (the negative values become positive) while the half wave rectifier only takes the positive values of the ac voltage at the load(negative values are zero). The full-wave rectifier has a higher ripple voltage frequency in comparison to that of the half-wave rectifier.

Question 2

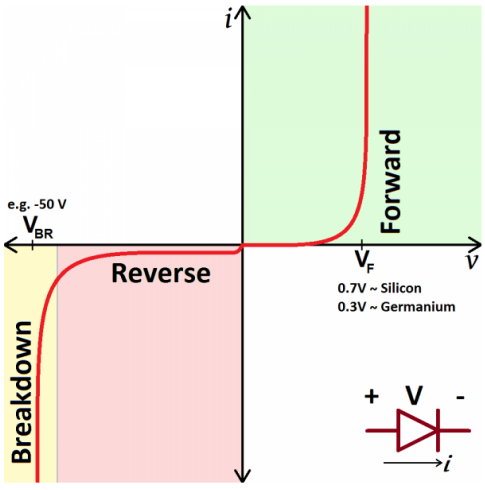


Figure 6: A diode conducts when the voltage difference between the cathode and the anode is above VF(for silicon 0.7 V and for germanium 0.3 V).

Question 3

Rectifier	Current across load C/mA	Current across load (no C)/mA
Half-Wave	4.2	3.7
Full-Wave	3.9	3.5

Table 1: Were C denotes a capacitor present.

From the table the addition of a capacitor decreases the current through the load. This is because the current from the diodes split into the capacitor and the resistor. The current across the diodes should increase with the addition of the capacitor because the impedance in the circuit decreases so the total current of the circuit should increase.

Question 4

The ratio of C*RL From the ripple peak-to-peak voltage formula as the capacitance increases ripple peak-to-peak voltage decreases we observe from the formula that when the capacitor is has a higher value the ripple peak-to-peak value decreases so the value of the ripple voltage approaches dc voltage.

Problem:Zener Diodes

Question 1

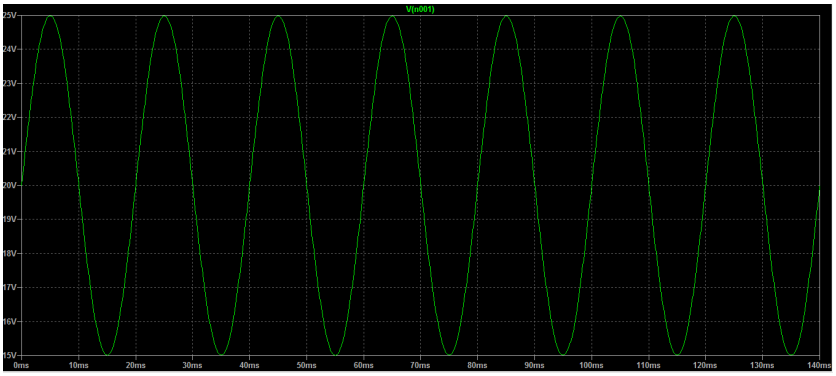


Figure 7: This is the input voltage.

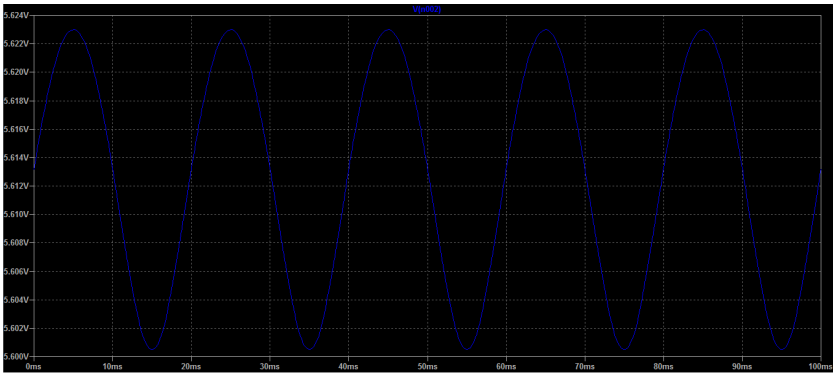


Figure 8: This is the voltage across the load.

Question 2

The function of a regulator is to provide a constant output voltage to a load connected in parallel with it in spite of the ripples in the supply voltage or the variation in the load current and the zener diode will continue to regulate the voltage until the diodes current falls below the minimum value(200 mA) in the reverse breakdown region.

Execution

Problem 1: Diode Switching Characteristic

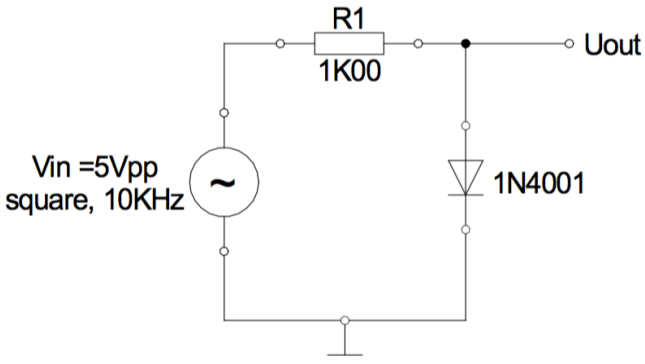


Figure 9: The circuit above shows the circuit we were supposed to implement.

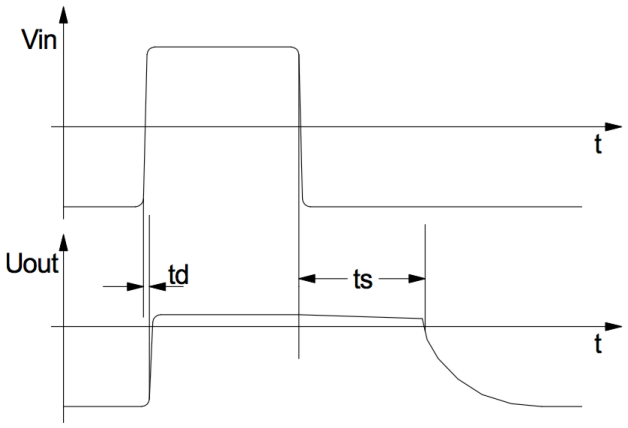


Figure 10: The graph shows as the values we supposed to obtain.

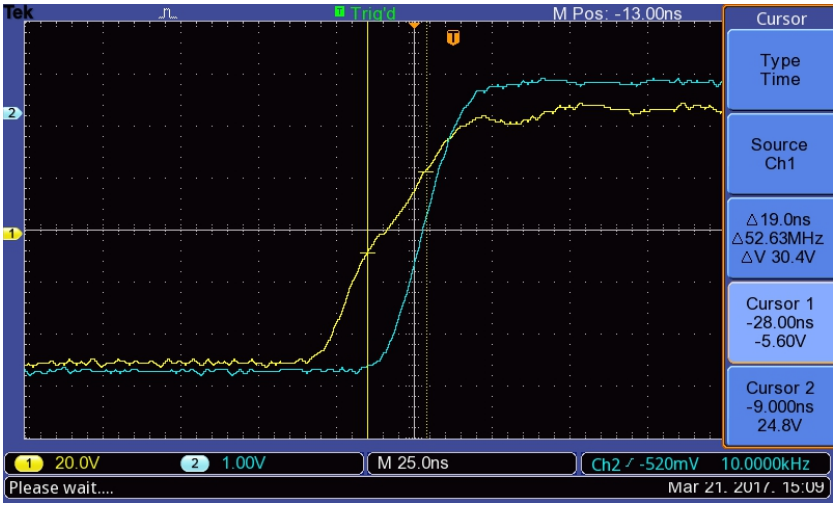


Figure 11: The graph shows the rise of the input and output signal.The differences in the values is $t_d = 19ns$.

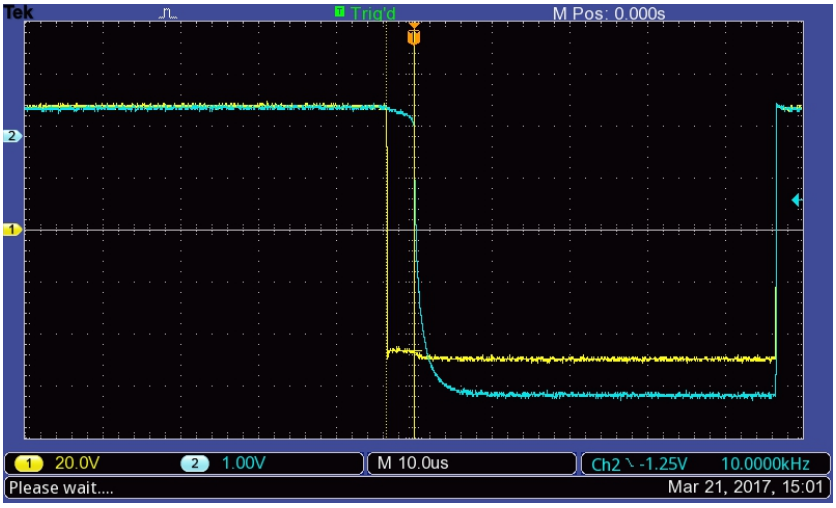


Figure 12: The graph shows the fall of the input and output signal.The differences in the values is $t_s = 13\mu s$.

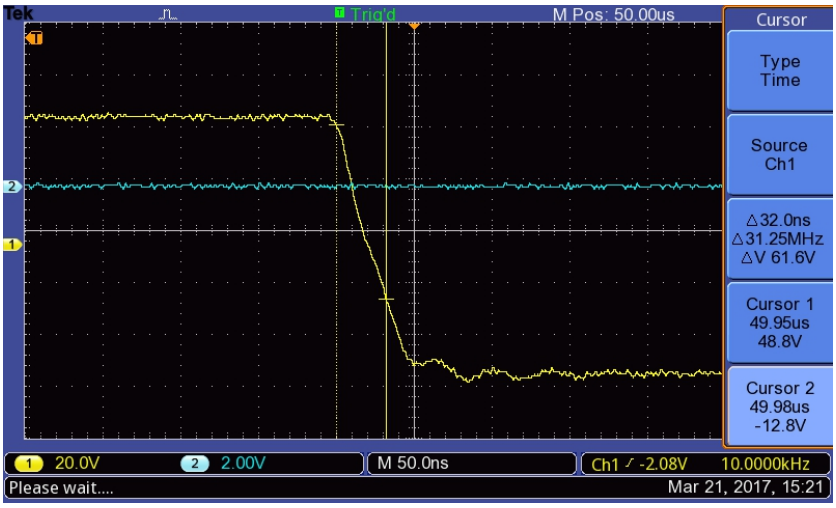


Figure 13: The graph shows the fall of the input and output signal with a new diode(1N4148) .The differences in the values is $t_s = 32ns$.

The diodes need a long time to switch off because the minority carriers that were established in the junction region with forward current must first be recombined with opposite polarity charge. It is due to the storage of excess minority carriers in the neutral regions of the diode.

At high frequencies, the input voltage reverses rapidly. In AM demodulation, with the envelope detector, the storage time of the diode should be small or the diode voltage will not be able to reverse at a similar speed .

Problem 2:Rectifier

Half-Wave Rectifier

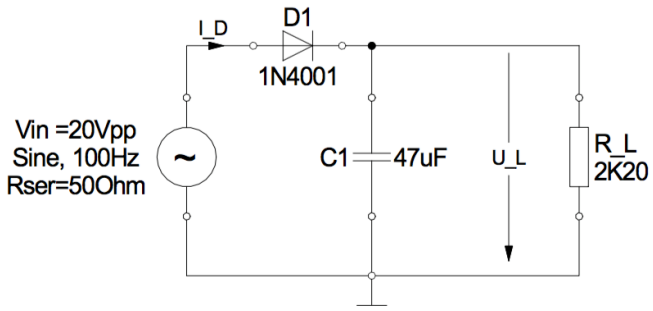
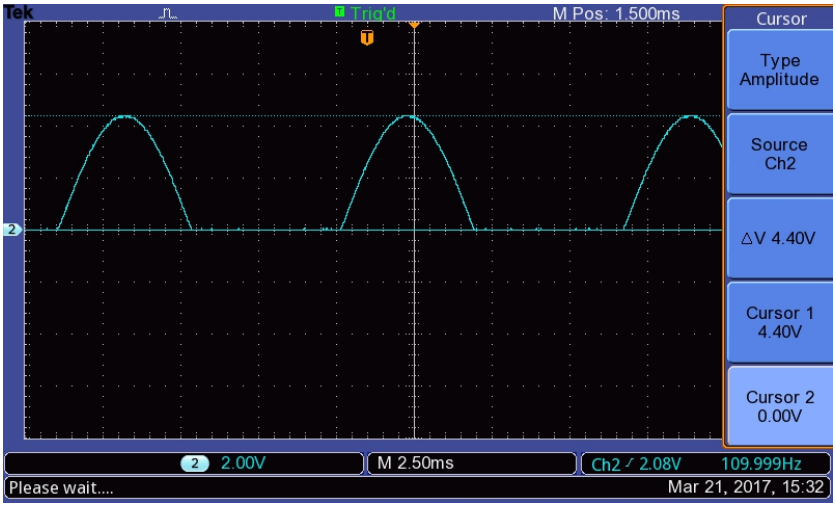


Figure 14: The circuit above shows the circuit we were supposed to implement.



1

Figure 15: The graph above shows the output voltage of the above circuit, but the capacitor is shorted.Peak voltage is 4.4V.

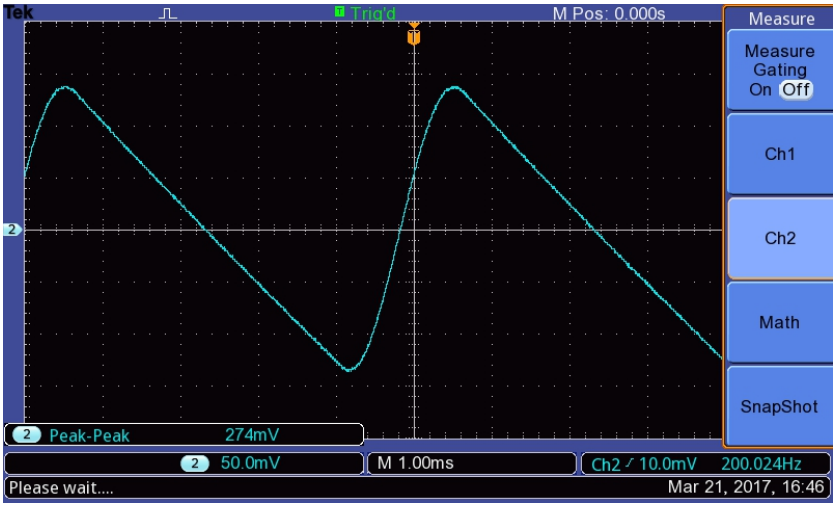


Figure 16: The graph above shows the output voltage of the above circuit.Peak-to-peak voltage is 274mV.

Full-Wave Rectifier

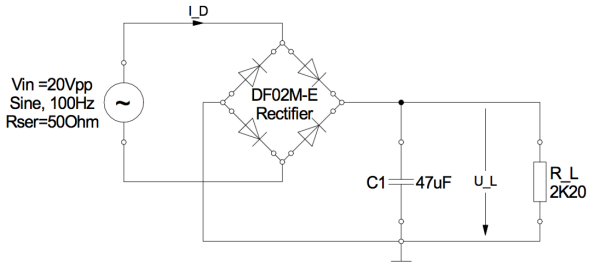


Figure 17: The circuit above shows the circuit we were supposed to implement.

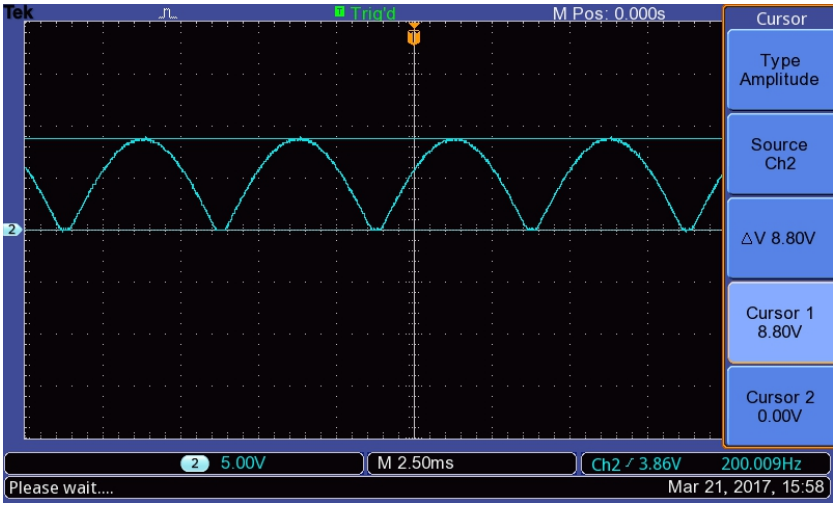


Figure 18: The graph above shows the output voltage of the above circuit, but the capacitor is shorted.Peak voltage is 8.8V.

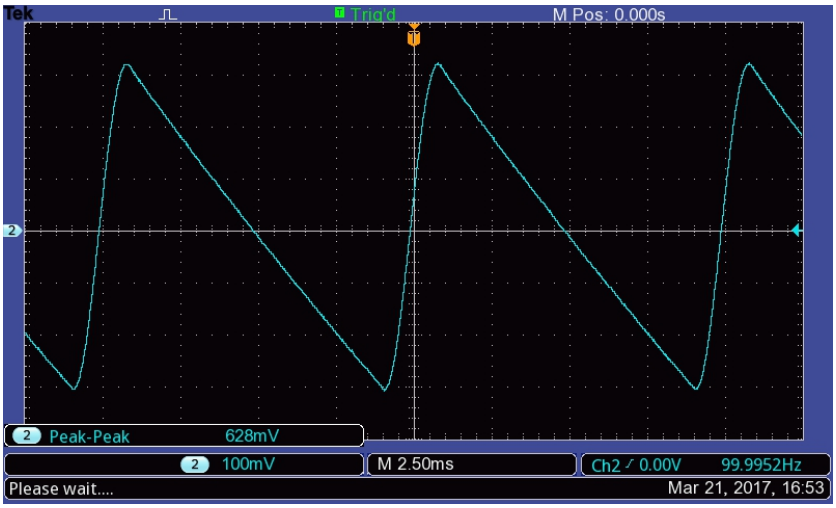


Figure 19: The graph above shows the output voltage of the above circuit.Peak-to-peak voltage is 628 mV.

The step-down transformer converts the high voltage AC supply to low voltage AC Voltage which is safe for home consumption when the voltage is converted to a DC voltage.
The rectifier Converts the sinusoidal AC voltage to an approximation of a DC voltage.
The filter removes unwanted ripples from the rectified output.
The regulator regulates the output voltage over the load.

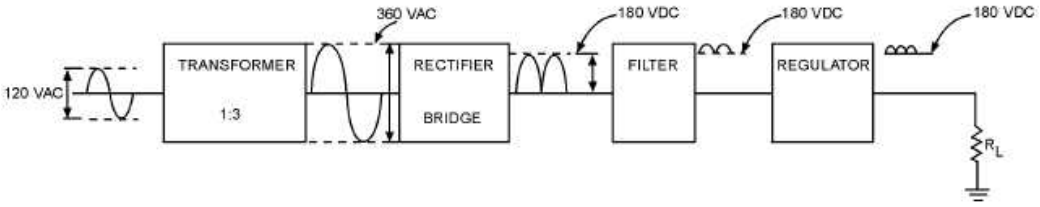


Figure 20: This is a block diagram of a DC power supply.

Calculated Voltage ripple
Half-Wave rectifier
Using Matlab:

```
ri=50;
rl=2.2e+03;
f=100;
c=47e-06;
vp=4.4;
format long
Vr=(vp./(f.*c.*rl)).*(1-(ri./rl)^(1./4))
```

The calculated ripple voltage= 0.2603 V

Calculated Voltage ripple
Full-Wave rectifier
Using Matlab:

```
ri=50;
rl=2.2e+03;
f=100;
c=47e-06;
vp=8.8;
format long
Vr=(vp./(2.*f.*c.*rl)).*(1-(ri./rl)^(1./4))
```

The calulated ripple voltage= 0.2603 V

Rectifier	Simulation/mV	ActualValues/mV
Half-Wave	516.2	260.3
Full-Wave	260.3	260.3

Table 2: From the values we can see that the value of the actual value of the ripple voltage of the half wave rectifier is wrong.This is because the Voltage peak to peak in the experiment is half the value in the simulation.

Problem 3:Zener Diodes

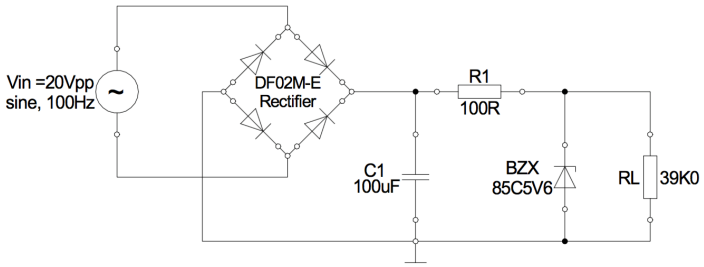


Figure 21: The circuit above shows the circuit we were supposed to implement.

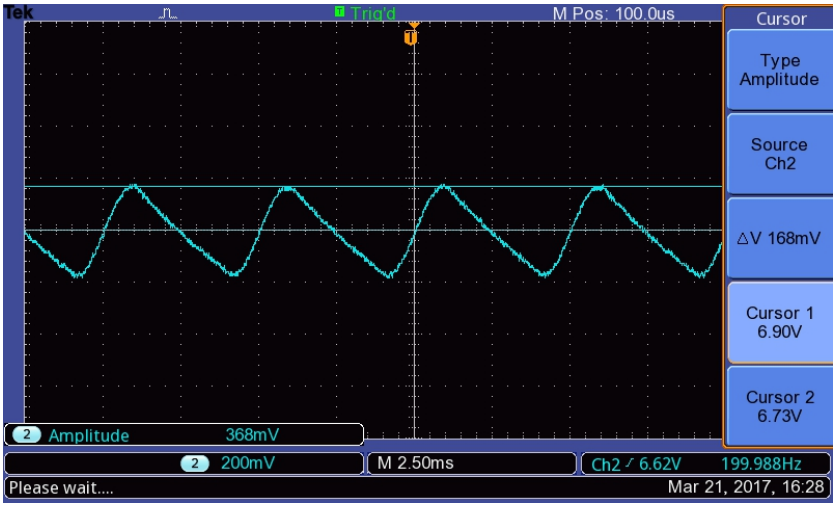


Figure 22: The graph shows the voltage across C1 with a peak-to-peak of 368mV.

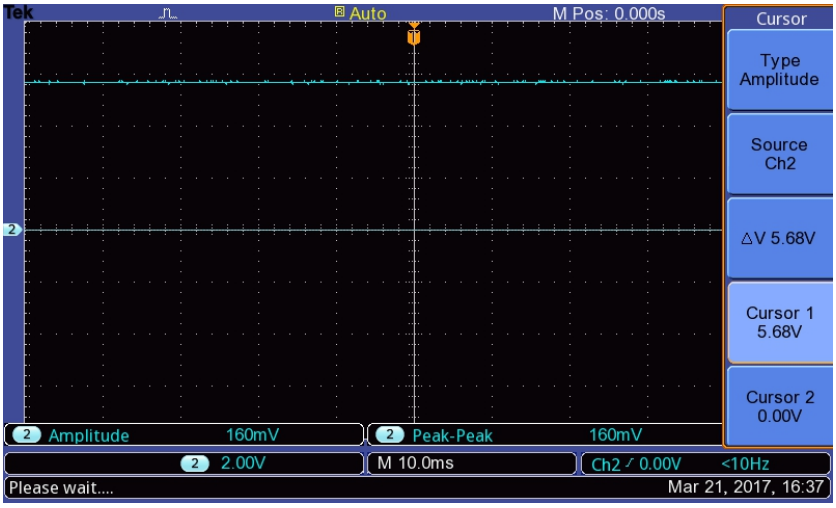


Figure 23: The graph shows the DC output voltage at 5.68 V.

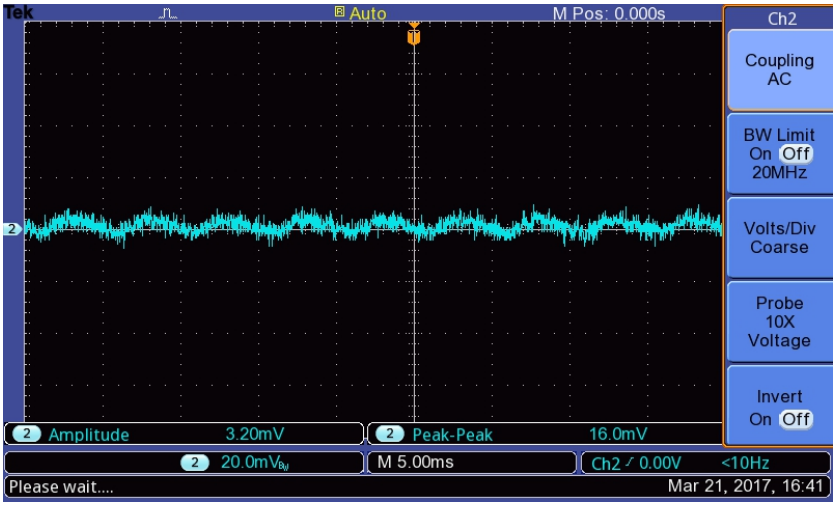


Figure 24: The graph shows the ripple voltage across the load resistor with a peak-to-peak of 16mV.

Problem 4: Voltage Multiplier

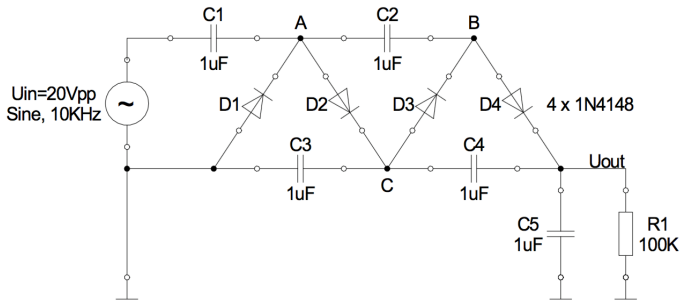


Figure 25: The circuit above shows the circuit we were supposed to implement.

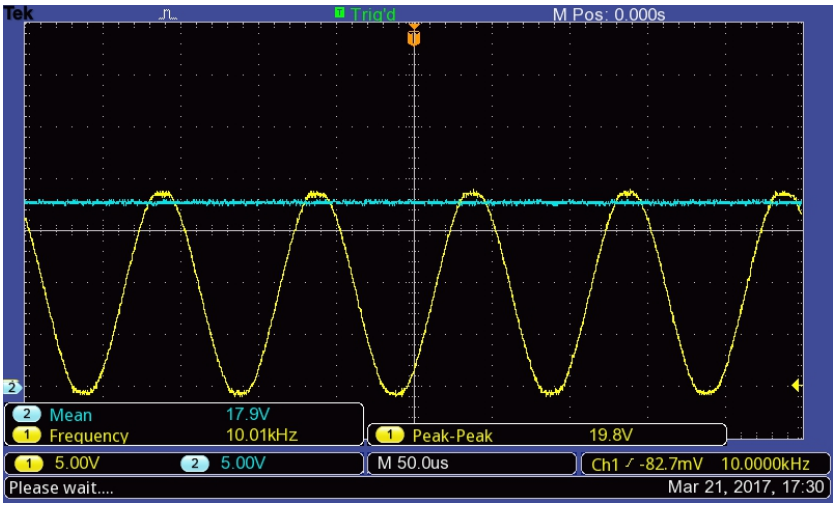


Figure 26: The graph shows the voltage at A (sinusoidal and at C(the straight line).

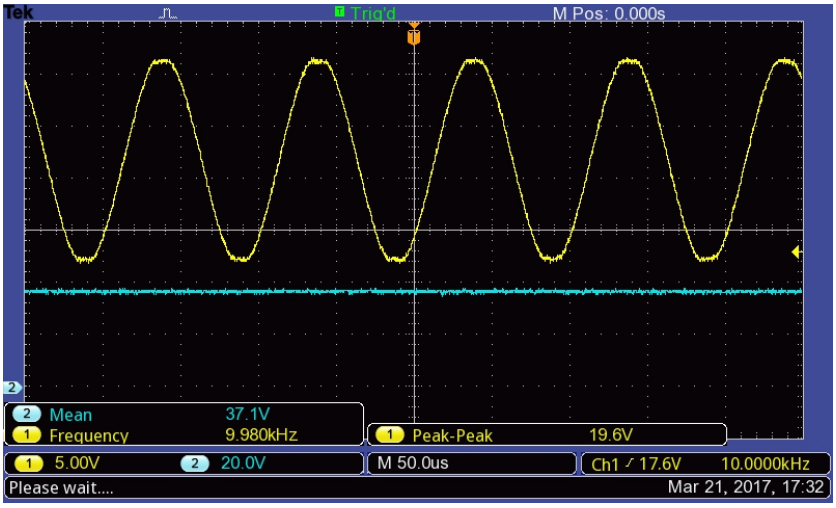


Figure 27: The graph shows the voltage at B (sinusoidal and at Uout(the straight line).

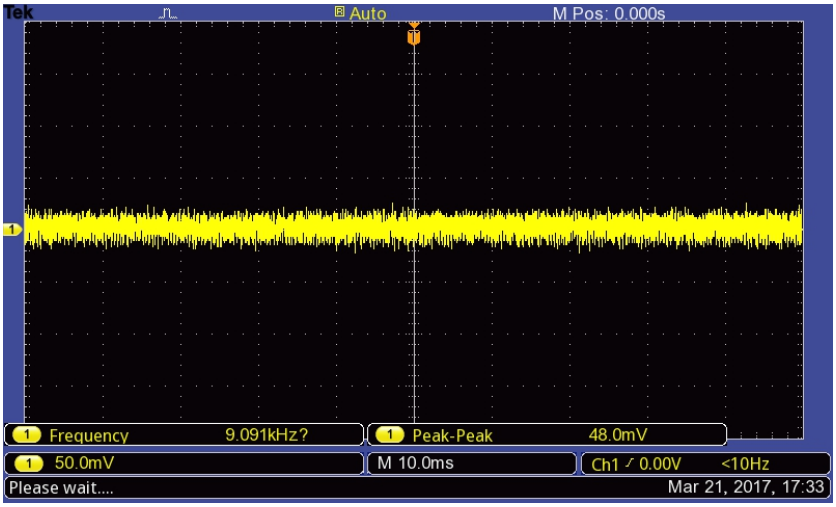


Figure 28: The graph shows the ripple voltage at U_{out} with a peak-to-peak of 48 mV.

Using the Tenma multimeter we measured the voltages at C which was 17.72 V and $U_{out} = 35.43V$

1. This circuit is composed of positive and negative clamper circuits.
2. The function of the circuit is to deliver a dc voltage that is a multiple of the peak value of the input ac voltage.

3. The multiplication factor between input amplitude and output voltage is four. There is a difference between the measured and ideal value since the capacitor discharges a through the load R_1 therefore the voltage across the capacitor drops slightly.

4. Each element should be selected for the maximum voltage of the AC input.

5. Using LTSpice one can see that the frequency of the input voltage is the same as the frequency at the output.

Conclusion

In this experiment we saw that simulated values are approximately equal to the calculated values and the actual values.We saw that the margin of error was very small.When measuring the peak-to-peak voltage we realized that the value was got was small than expected.We must have accidentally entered the wrong peak-to-peak voltage in the signal generator.

Reference

Author SparkFun V3.2
Article title: Diodes - learn.sparkfun.com
Website title: Learn.sparkfun.com
URL: https://learn.sparkfun.com/tutorials/diodes

Author How datasheet?
Article title: How to calculate minimum zener current if it
is not explicitly specified in the datasheet?
Website title: Electronics.stackexchange.com
URL: http://electronics.stackexchange.com/questions/80145/
how-to-calculate-minimum-zener-current-if-it-is-not-explicitly-specified-in-the

Website title:Uk.farnell.com
URL:http://uk.farnell.com/vishay/bzx55c5v6-tap/
diode-zener-5-6v-0-5w-5-do35/dp/1779202

Website title:

Electriciantraining.tpub.com
URL: http://electriciantraining.tpub.com/14178/img/14178_110_2.jpg

Article title:Zener Diode as Voltage Regulator Tutorial
Website title:Basic Electronics Tutorials
URL: http://www.electronics-tutorials.ws/diode/diode_7.html