Course: CSE251

Lab Report (1, 2, 4, 5)

Section: 5

Lab group: 7

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Name and ID:

Md. Shakil Bhuiyan (2020-2-60-021)

Nadia Sultana (2020-2-60-024)

Israt Jahan Jarin (2020-2-60-032)

Md. Ashiqur Rahman Dipu (2019-3-60-065)

Md. Abu Zafor (2020-2-60-158)

Submitted To:

Surajit Das Barman

Senior Lecturer

Department of Computer Science & Engineering

Experiment 1:

Title: I-V Characteristics and Modeling of Forward Conduction of a Diode.

Objectives:

1. To measure the I-V characteristics of forward conduction of a p-n junction diode.
2. To determine the models of forward conduction of a p-n junction diode.

Circuit Diagram:

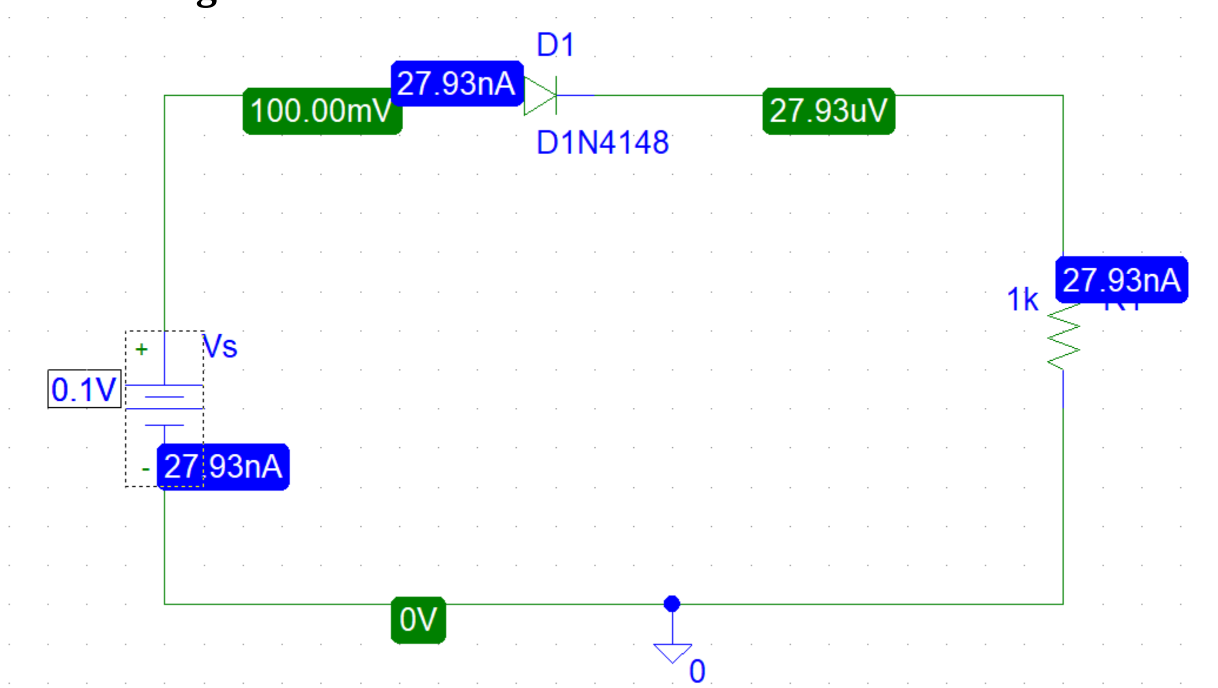


Table 1:

V_s	V_D	V_R	I_D
0	0	0	0
0.1	0.1	0	0
0.2	0.2	0	0
0.3	0.3	0	0
0.4	0.4	0	0
0.5	0.5	0	0
0.6	0.497	0.103	0.103
0.7	0.523	0.177	0.177
0.8	0.540	0.251	0.251
0.9	0.554	0.345	0.345
1	0.565	0.435	0.435
1.5	0.599	0.900	0.900
2	0.62	1.380	1.380
2.5	0.635	1.865	1.865
3	0.646	2.354	2.354
3.5	0.656	2.844	2.844
4	0.664	3.336	3.336
4.5	0.671	3.829	3.829
5	0.677	4.323	4.323
5.5	0.683	4.817	4.817
6	0.688	5.312	5.312
6.5	0.693	5.807	5.807
7	0.697	6.303	6.303
7.5	0.701	6.799	6.799
8	0.707	7.295	7.295
8.5	0.709	7.791	7.791
9	0.712	8.288	8.288
9.5	0.715	8.785	8.785
10	0.718	9.282	9.282

Post lab question answers:

1. Using PSpice, plot the I-V characteristics of the P-N junction diode in forward conduction.

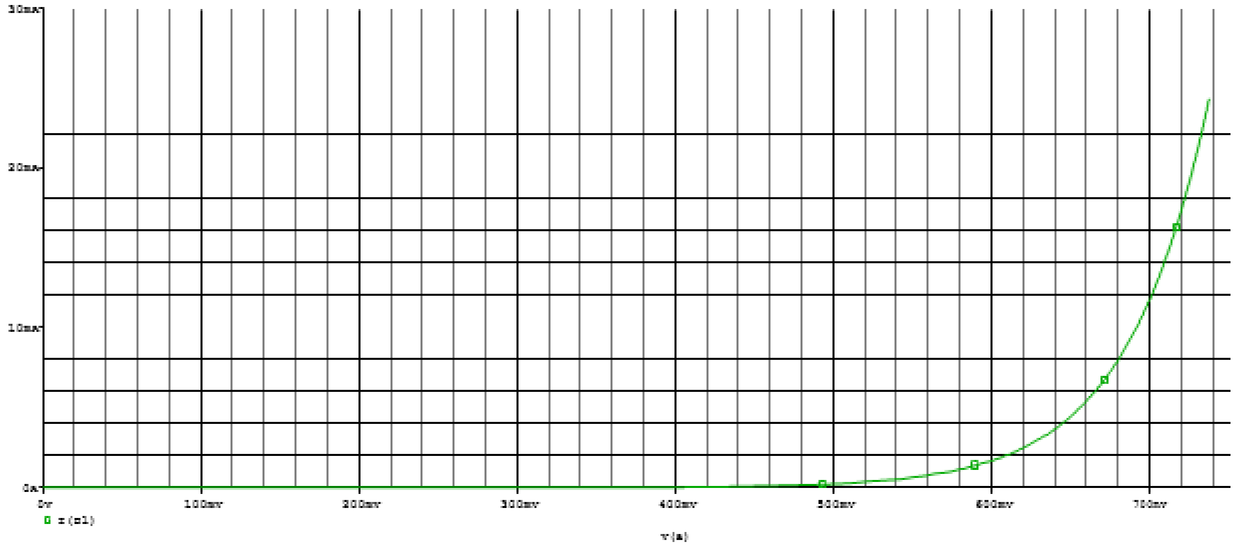


Figure: I-V characteristics of P-N junction diode in forward conduction.

2. Calculated value I_S and n from the Graph.

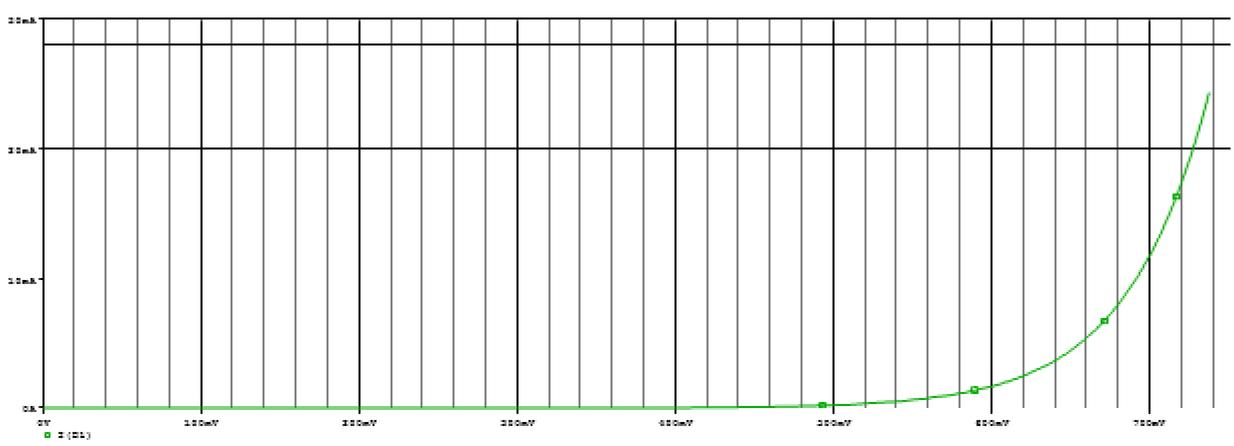


Figure: I-V characteristics of P-N junction diode in forward conduction.

Here,

$I_{D1} = 2.5mA$, $I_{D2} = 2mA$, $V_{D1} = 0.65V$, $V_{D2} = 0.64V$ and $V_t = 0.0259$

We know,

$$V_{D1}-V_{D2} = V_t \ln\left(\frac{ID1}{ID2}\right)$$

After calculating, n = 1.73

Again,

We know,

$I_{D1}= I_S exp[V_{D1}/V_T]$

$=> I_S=I_{D1}/exp[V_{D1}/V_T]$

$=> I_S= (2.5 \times 10^{-3})/exp[\frac{0.65}{73 \times 0.0259}]$

$=> I_S =$ 1.25 nA.

3. Determine the cut-in voltage from the graph.

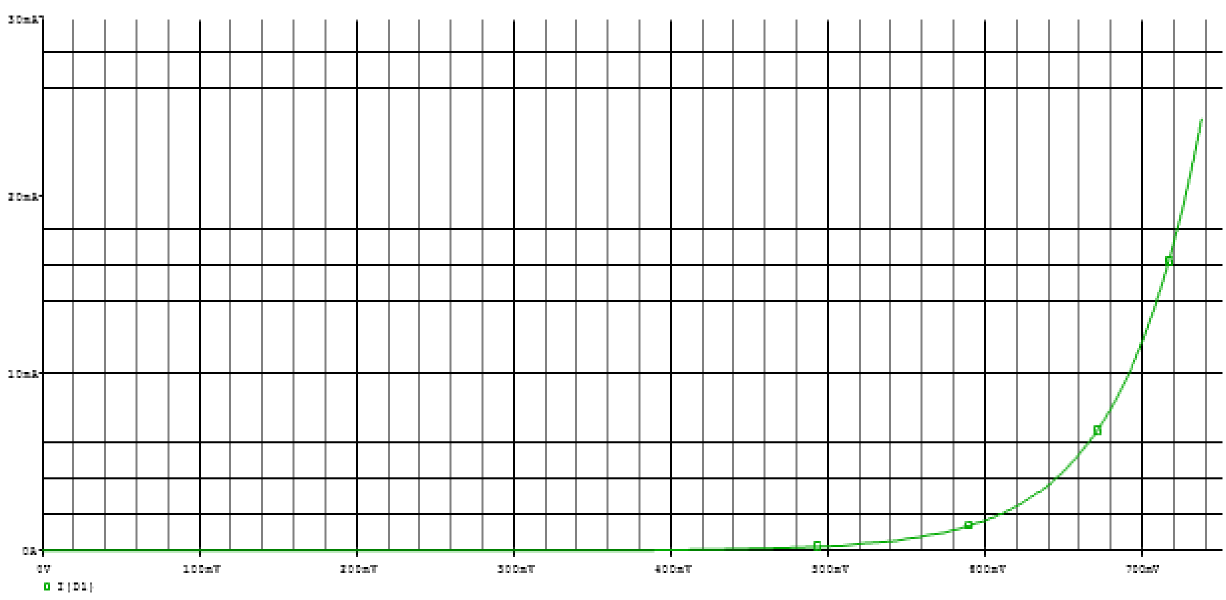


Figure: 3

4. Calculated value r_D from the data using the equation.
   Here,

I_{D1} = 2.5 mA and V_{D1} = 0.65V

And, I_{D2} = 2.0 mA and V_{D2} = 0.64V

we know,

$1/ r_D = (I_{D2} - I_{D1})/(V_{D2} - V_{D1})$

So, the value of r_D = 0.02 Kohm

5. Simulate the circuit of Figure 1 for a DC bias (VS) range of 0-5 volts using PSpice.

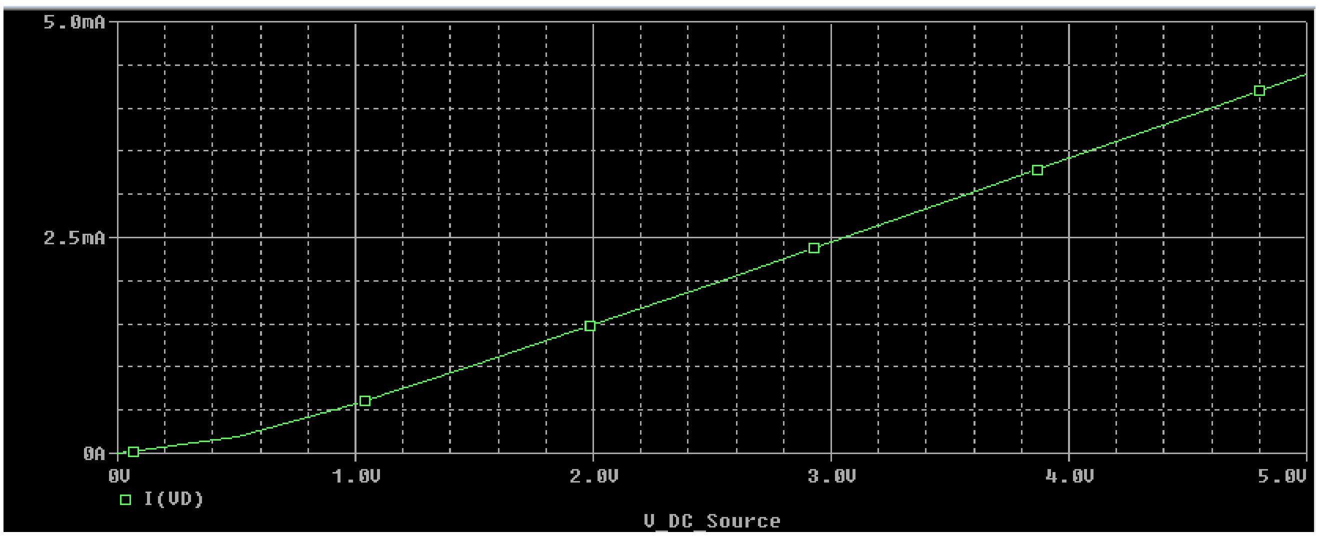


Figure: I_D VS V_S graph.

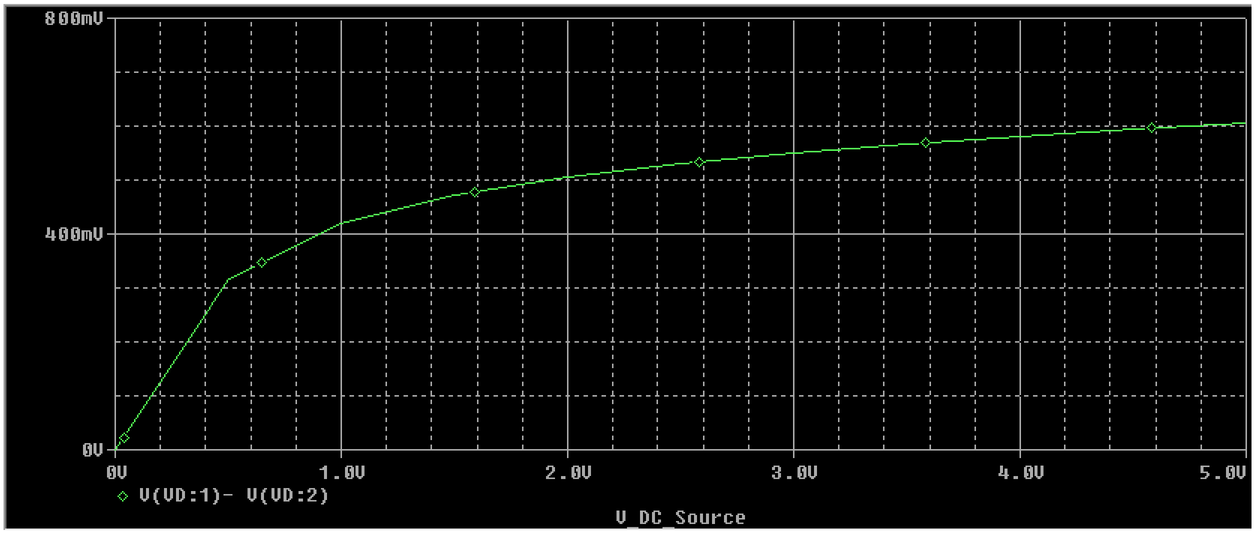


Figure: V_D VS V_S graph.

Conclusion:

The V-I characteristics or voltage-current characteristics of the p-n junction diode is shown in the figure. The horizontal line in the below figure represents the amount of voltage applied across the p-n junction diode whereas the vertical line represents the number of current flows in the p-n junction diode

An ideal diode, in forward conduction act like a short circuit but here in practical diode it consumes some voltage to act like short circuit, but still, it doesn’t act like short circuit fully because of leak voltage.

Experiment 2:

Title: Half-Wave Diode Rectifier Circuit

Objective:

Designing half-wave rectifier circuits with diodes and other related sources. Find the correct value and error and decide how to overcome it and find out the effect of any capacitor on the result of half-wave rectifier and filter circuit.

Circuit:

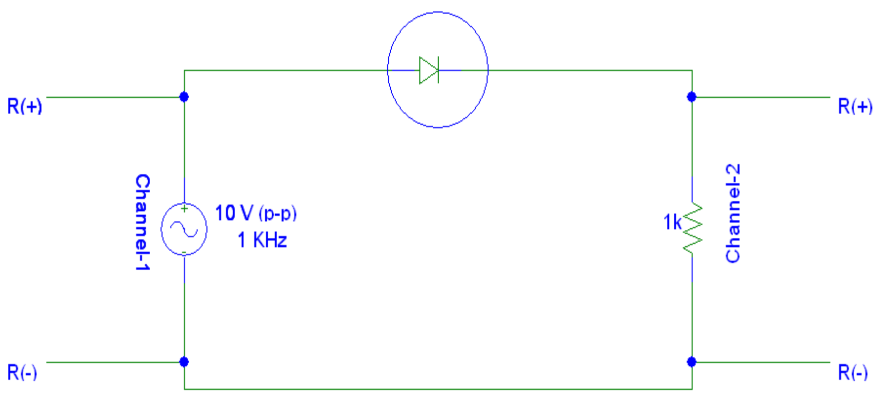


Figure: Set up for a half-wave diode rectifier.

Post lab questions answer:

1. Comparison between the measured values of ΔV_P with a built-in voltage:

Measured value of ΔV_P	Built-in voltage
0.56V	5V

2. Comparison between the measured value of Δt with pre-lab value of Δt.

Measured value of Δt	Pre-lab value of Δt
120	1.29 ms

$$V_r = 0.4V$$

3. Peak to peak ripple voltage,

let , W=2πf

$$f = 1000$$

Now,

$$\omega\Delta t = \sqrt{\frac{2V_r}{V_p}}$$

$$=>(\omega\Delta t)^2 = \frac{2V_r}{V_p}$$

$$=>V_r = \frac{(\omega\Delta t)^2 * V_p}{2}$$

$$=>V_r = \frac{(2*3.1416*1000*1.29*10\text{^}-3)^2*5}{2}$$

$=>V_r$=164.241 V

Calculated value of V_r	Measured value of V_r	Pre-lab value of V_r
164.241	0.40V	0.50V

4. Average output voltage,

$$V_0 = V_P - \frac{V_r}{2}$$

$$=> V_0 = 5 - \left(\frac{0.40}{2}\right) = 4.8V$$

Measured value of V_0	Calculated value of V_0
3.27 V	4.8V

5. Here, Measured value of Resistance, $R = 1\ K\Omega$,

Ripple voltage, $V_r = 0.40\ V$,

Output voltage, $V_0 = 3.27V$

Now,

$$I_L = \frac{V_0}{R}$$

$$=> I_L = \frac{3.27}{1} = 3.27mA$$

$$I_{D\ avg} = I_L\left(1 + \pi\sqrt{\frac{2V_p}{V_r}}\right)$$

$$=> I_{D\ avg} = 3.27\ (1 + 3.1416\sqrt{\frac{2*5}{.40}})$$

$$=> I_{D\ avg} = 54.635\ mA$$

$$I_{D\ max} = I_L\left(1 + 2\pi\sqrt{\frac{2V_p}{V_r}}\right)$$

$$=> I_{D\ max} = 3.27\left(1 + 2 * 3.1416\sqrt{\frac{2*5}{0.40}}\right)$$

$$=> I_{D\ max} = 106mA$$

Current	Calculated value	Pre-lab value
I_{Davg}	54.635 mA	71.44 mA
I_{Dmax}	106mA	137mA

Comment: After observing the values, we can say that, Calculated Value and pre-lab values is almost same.

6.

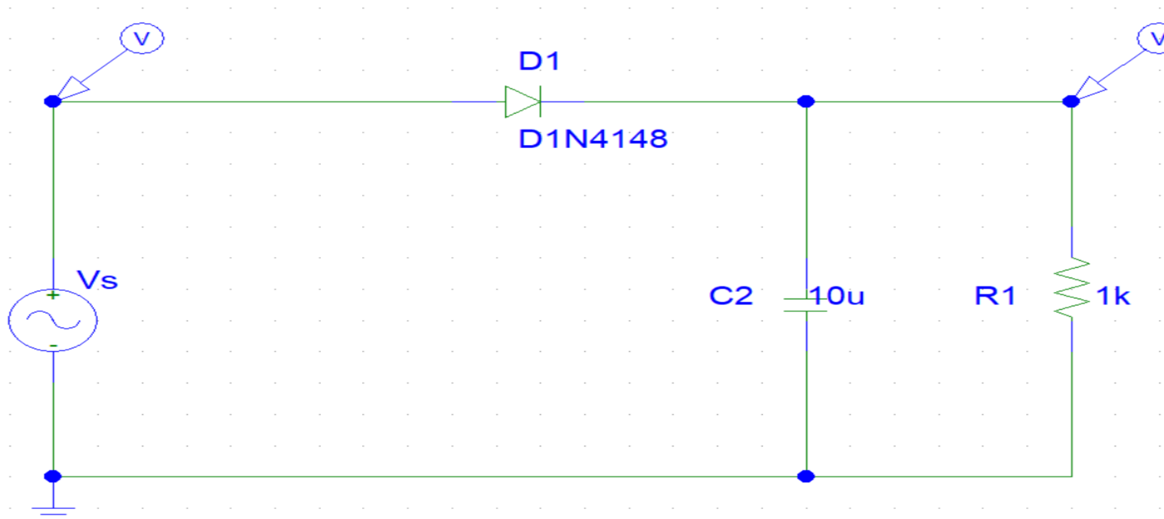
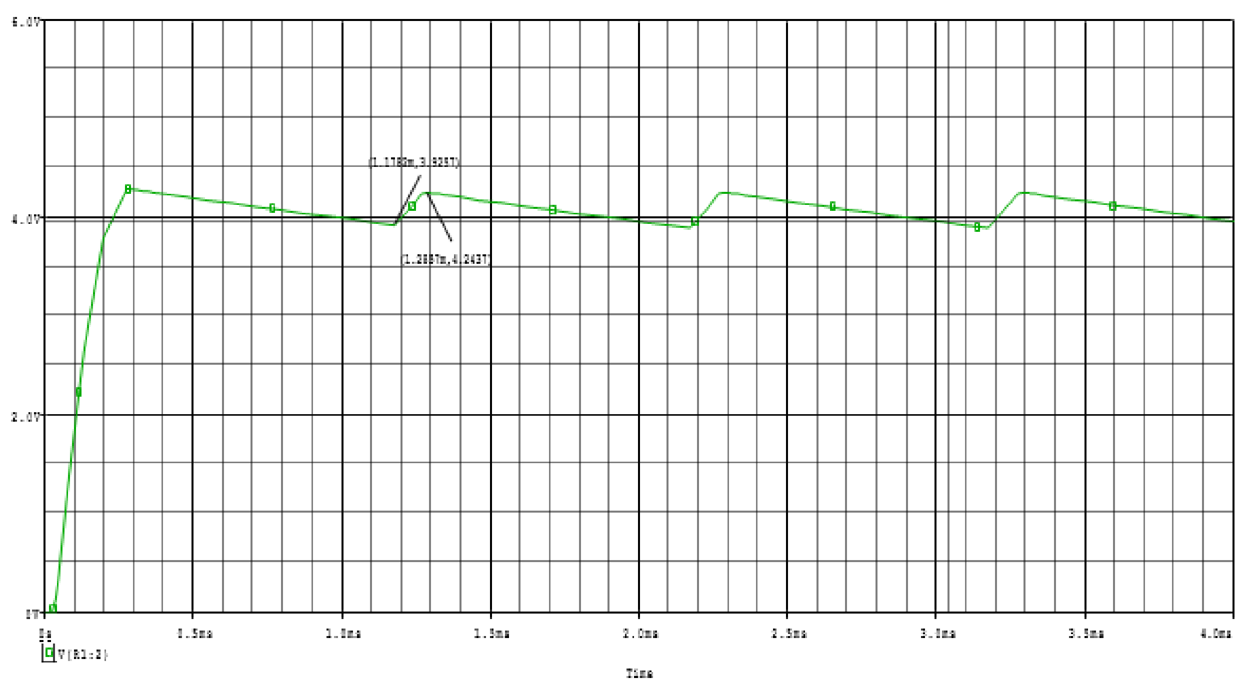


Figure: Set up for a half wave diode rectifier circuit.



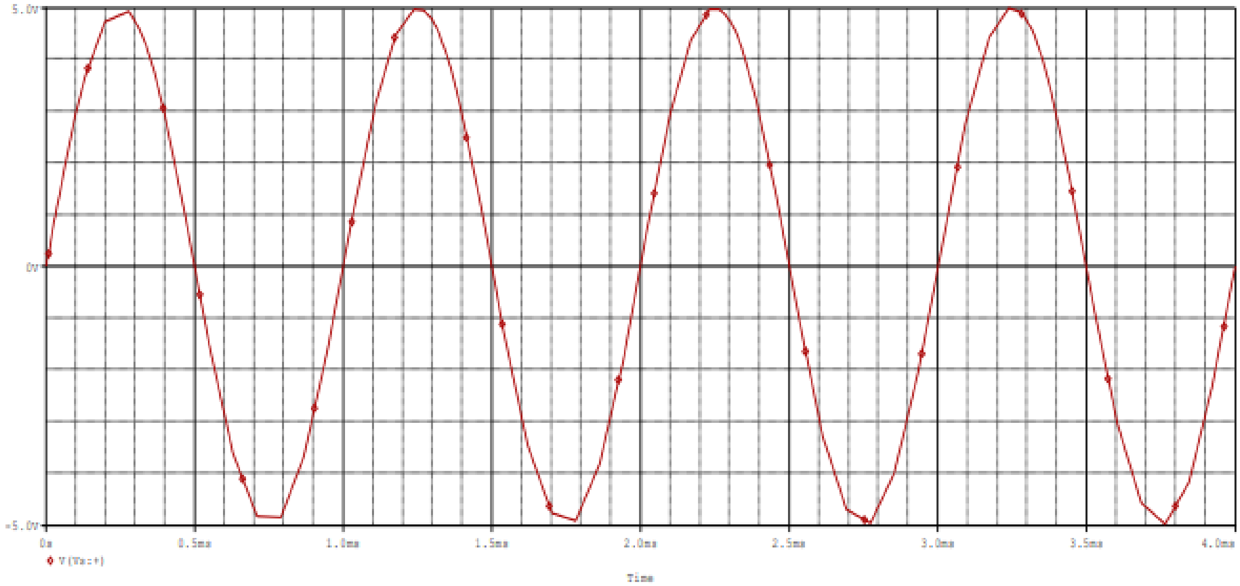


Figure: The sin-wave of half wave rectifier.

Conclusion:

In this experiment, we have learned the characteristics of a diode. We also learned how to make a peak rectifier circuit from a half-wave rectifier circuit. We learned the effect of a capacitor and how can it reduce the ripple of the output voltage.

Experiment 4:

Title: Adder and Amplifier Circuits Using a 741 Op-Amp.

Objectives:

1. To familiarize with the 741 Op Amp Integrated Circuit (IC).
2. To design and construct an adder using 741 Op Amp.
3. To design and construct an amplifier using 741 Op Amp.

Circuit Diagram:

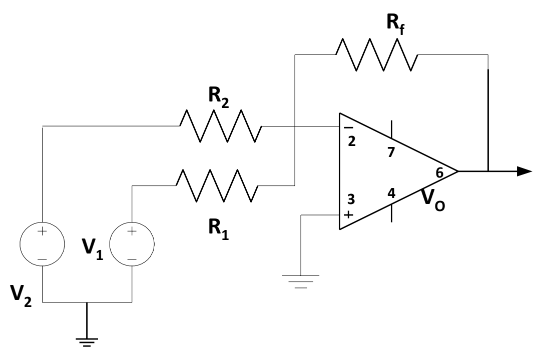


Figure: An adder circuit using 741 Op Amp.

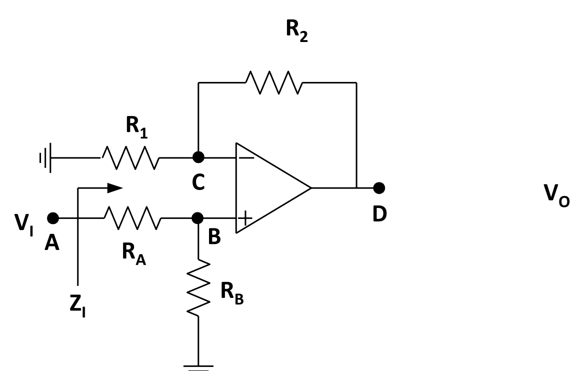


Figure: A non-inverting amplifier circuit using 741 Op Amp.

Post lab question answers:

Answer No: 1

Here, $V1=5V$; $V_2=2V$;

So, $V_o = -(V1+2V_2)$

$= -(5+4)$ V

$= -9V$

And from the measurement Output voltage, $V_o = -9.14V$

Answer No: 2

Amplitude measured in step 4 is = 10.05V As we use 5 V from AC power supply and the output take from DC mode. So, the amplitude increased 2 steps up in output. The output comes as like theory, so the circuit design is right.

Answer No: 3

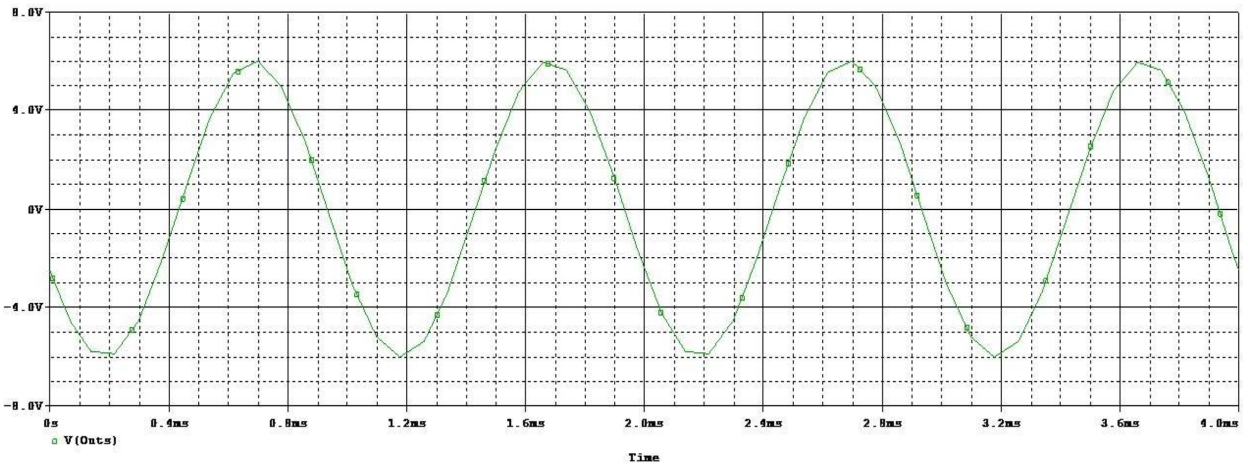


Figure: Simulation for cycles of Figure:1 using given value.

Answer No: 4

In Phasor domain,

V1 = $2.5\angle 0^0$V,

V2=$2.5\angle 90^0$V

V1 + V2 = $2.5\angle 0^0 + 2.5\angle 90^0 = 3.536\angle 45^0$ V

In time domain,

V1 = $2.5\sin(2000\pi t + 0^0)\ V$

V2 = $2.5\sin(2000\pi t + 90^0)\ V$

V1 + V2 =$2.5(\sin(2000\pi t + 0^0) + \sin(2000\pi t + 90^0))\ V$

From Pspice	From calculation
Amplitude =3.536	Amplitude =10.05
Phase angle=45^0	Phase angle=45^0
Time period =2ms	2ms

Answer No: 5

Comparison between measured voltages at nodes A, B, C, and D with pre-lab result:

Node	Pre-lab result (V)	Measured voltage (V)
A	1	1.02
B	0.82	0.83
C	0.82	0.81
D	4.5	4.7

Answer No: 6

Measured voltage of,

B = 0.83 V and C = 0.81V

Answer No: 7

Here voltage in node,

A = 1.02V

D = 4.7V
Gain = 4.7 / 1.02 = 4.6

From pre-lab our gain was = 5.00

Answer No: 8

Current through,

R_1 is $I_1 = 1.02 / 2.14k\Omega$
$= 0.47mA$
R_2 is $I_2 = 0.81 / 10.25k\Omega$
$= 0.08mA$
R_A is $I_A = 0.21/ 2.14k\Omega$
$= 0.09mA$
R_B is $I_B = 0.83 / 10.25k\Omega$
$= 0.081mA$

Comparison between measured Values and calculated Values:

Currents	Measured Values(mA)	Calculated Values(mA)
I_1	0.47	0.45
I_2	0.08	0.082
I_A	0.09	0.08
I_B	0.081	0.082

Answer No: 9

I_A = 0.09 mA,

Input Impedance: Z1= (V_A-V_B/I_{RA})

= (0.19V/ 0.09 mA = 2.11KΩ

Comparison between measured Values and calculated Values:

Impedance	Measured Values(KΩ)	Calculated Values(KΩ)
Z1	2.11	2.22

Experiment: 5

Title: Signal Integration and Differentiation Using 741 Op-Amp.

Objective:

1. To study the responses of Op-Amp integrator to sinusoid and square waveforms.
2. To study the responses of Op-Amp differentiator to sinusoid and triangular waveforms.

Circuit Diagram:

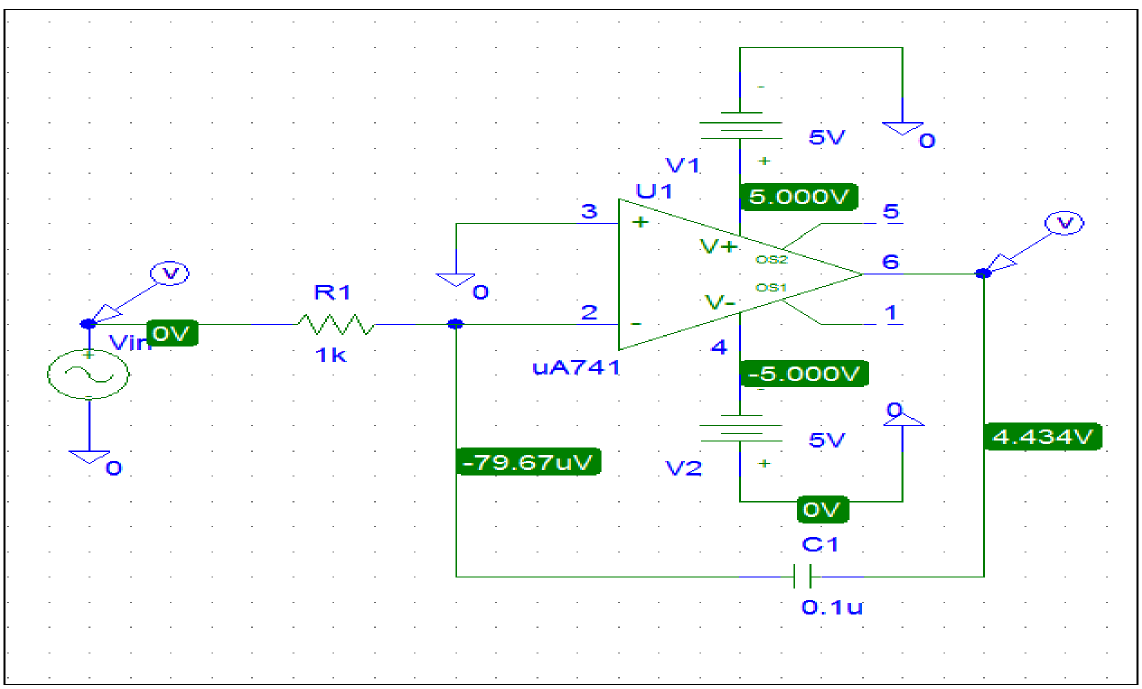


Figure: An op-amp integrator circuit.

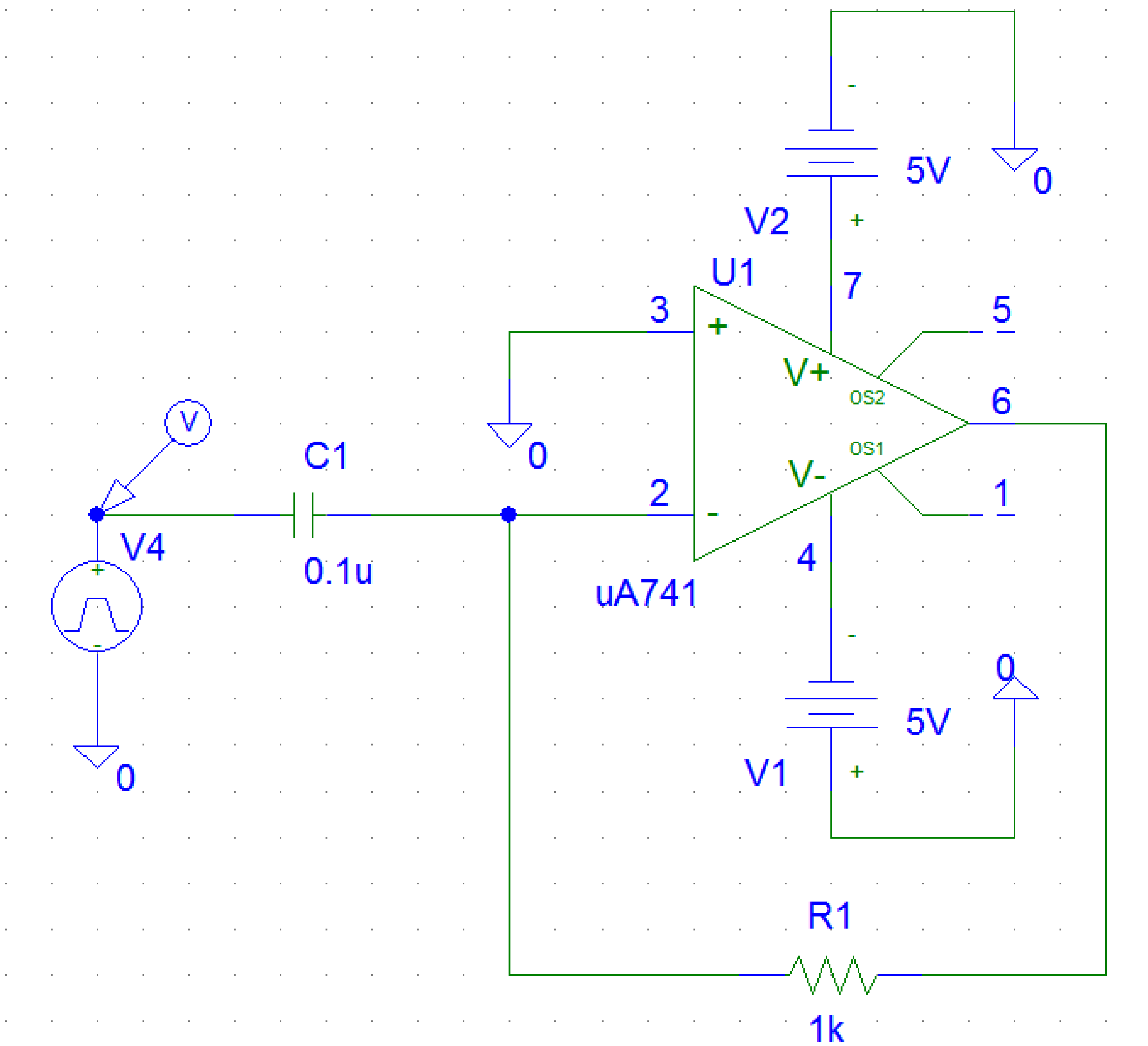


Figure: An op-amp differentiator circuit.

Post lab question answers:

Integrator

Answer No: 1

Here, R = 1Kohm, C = 0.1uF, $V_p = 1.76V$, f = 0.795Hz

We know,

Amplitude

$$= \frac{1.76}{2*3.14*0.795*1*0.1}$$

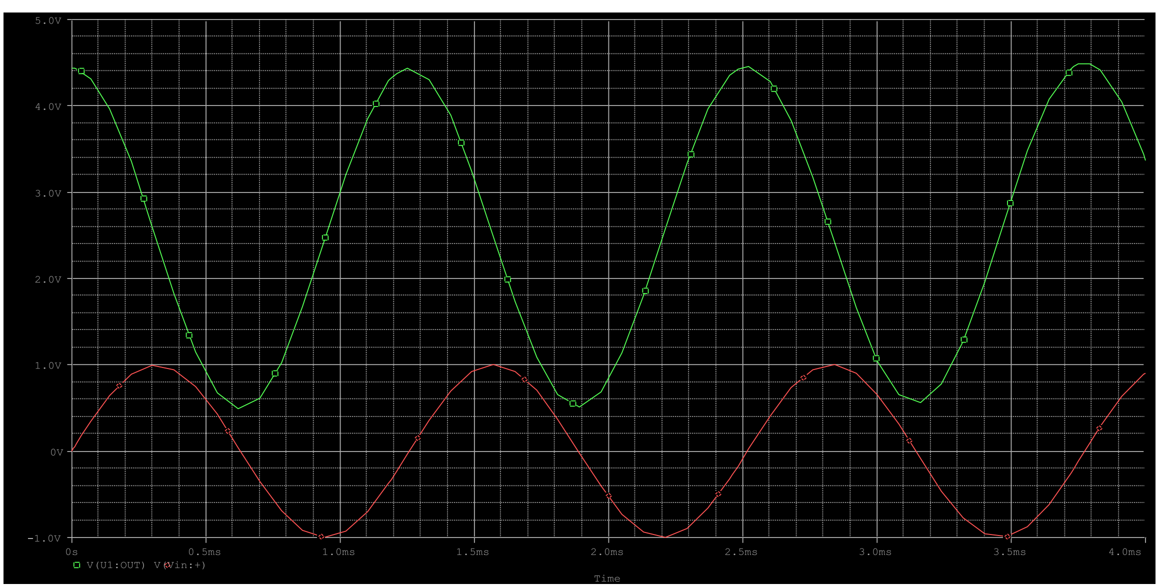
$$=3.52 \text{ V}$$

Comparison between the Calculated & Measured value of the amplitude of output signal:

Calculated Value = 3.52V and Measured Value = 3.52V

There is no difference since the experiment done on simulation.

Answer No: 2



Here,

T_{out} = 1.257ms

T_{in} = 0.943ms

We know,

$$\text{Phase diff} = 360 * f * \Delta t$$

$$= 360 * 0.795 * (1.257 – 0.943)$$

$$= 89.67$$

Pre lab Value: 90

Measured value: 89.67

From the data we can see that there is a slight difference between the Pre-lab value & measured value of the phase difference. That difference due to instrumental error.

Answer No: 3

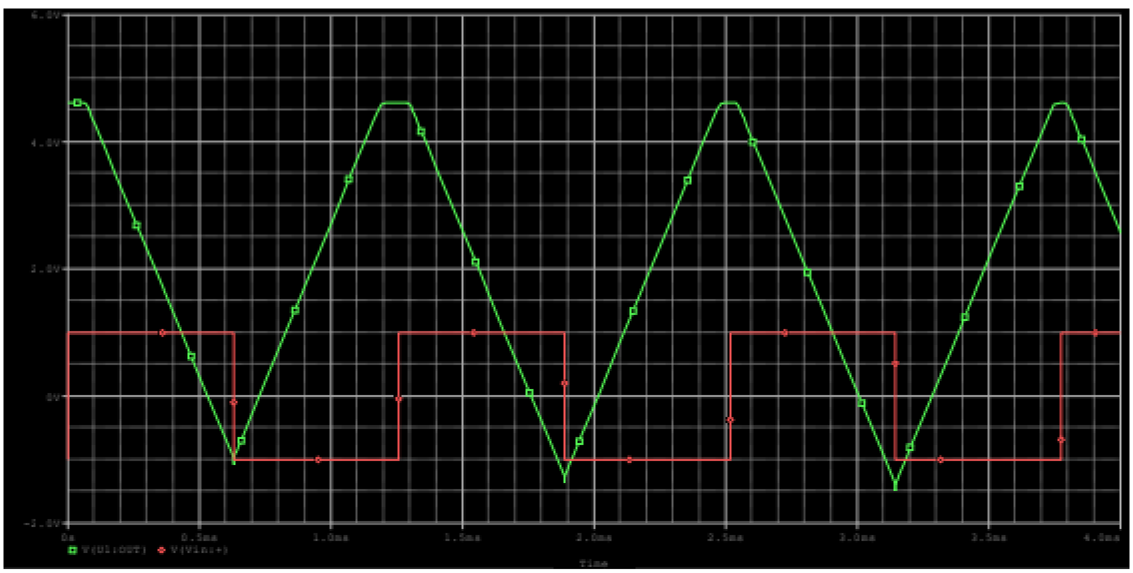


Figure: Integrator simulation.

Output signal:

Simulation value: 2.78

Measured value: 3.52

From the above table we can see that there is a slight difference between the Simulation value and measured value.

Differentiator

Answer No: 4

Here, R = 1Kohm, C = 0.1uF, Vp = 1.76V, F = 795 Hz

We know,

Amplitude Vo = Vp RC ω

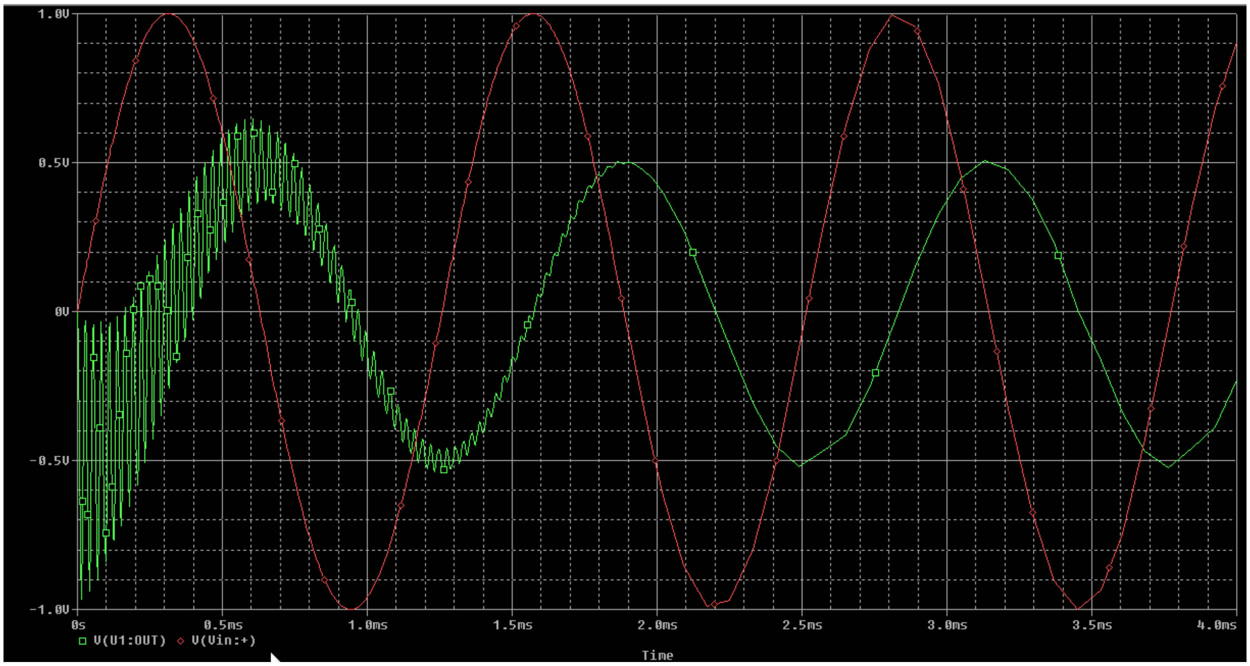
= 1.76 * 1 * 0.1*10^-6 * 2 * 3.14 * 795

= 0.879V

Calculated value: 0.879V Measured value: 0.84V

We see that there is a difference between the two values.

Answer No: 5



Here,

Tout = 2.8345ms

Tin= 2.5176ms

We know,

Phase diff = 360 * f * Δt

= 360 * 0.795 * (2.8345 – 2.5176)

= 90.696

Pre lab Value: 90

Measured value: 90.696

From the data we can see that there is a slight difference between the Pre-lab value & measured value of the phase difference. That difference due to instrumental error.

Answer No: 6

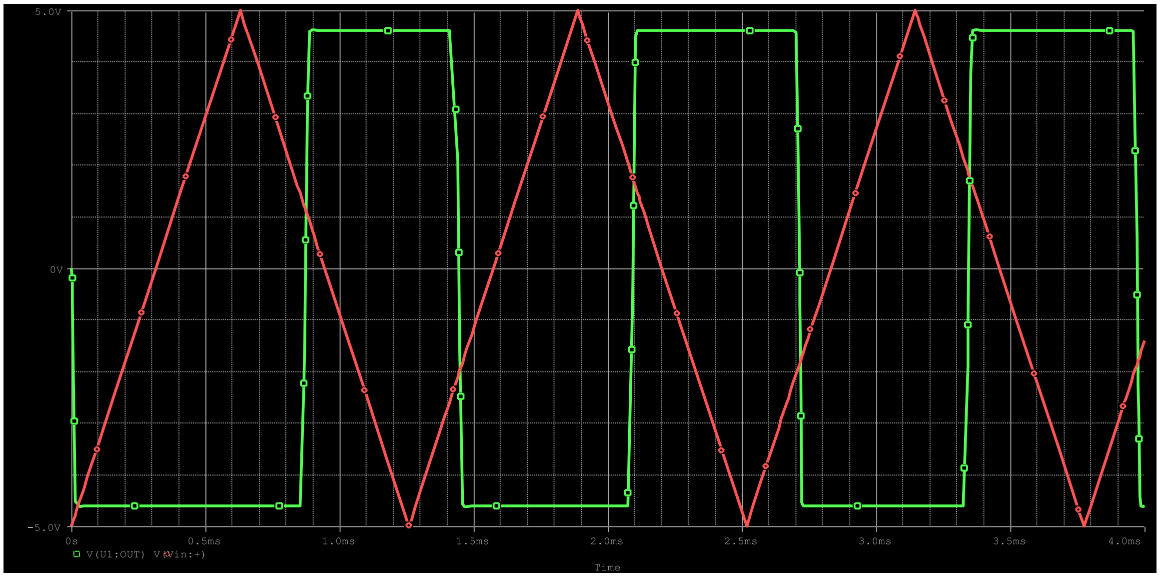


Figure: Differentiator simulation.

Comparison between the simulation and measured value of the output signal:

Simulation value: 0.62

Measured value: 0.84

From the above table we can see that there is a slight difference between the Simulation value and measured value.

Conclusion:

In this experiment, we have done the differential & integral circuit using 741 Op-Amp by simulation. We also learn how to simulate the differential & integral circuit using PSPICE for both square & triangular wave.

There were some different results from the expectation values. These errors can occur for various reasons.