EAST WEST UNIVERSITY
Department of Computer Science and Engineering

Lab-report:02

Course Name: Electronic Circuits
Course Code: CSE 251
Section No: 01

Name of experiment: Diode Rectifier Circuit

Submitted To:

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Objective(s) of the Experiment:

1. To study half-wave diode rectifier circuit.
2. To study the effect of a capacitor filter on the output of the rectifier circuit.

Circuit diagram:

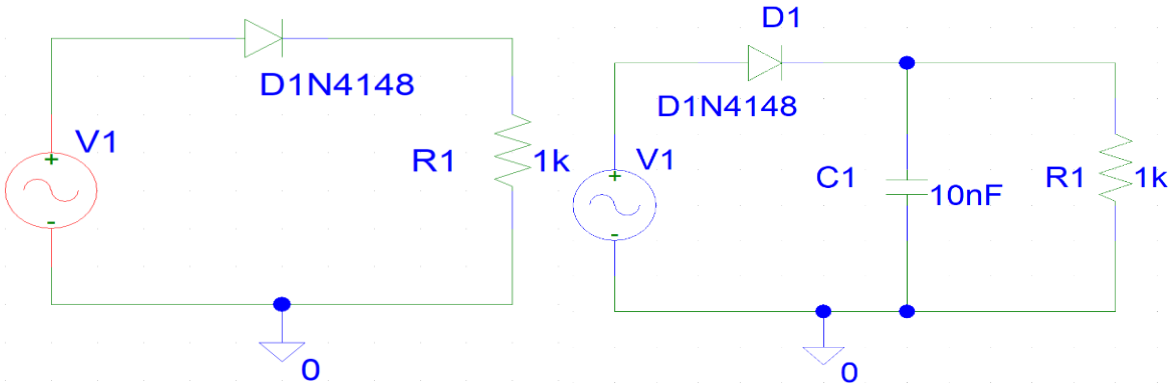

Figure 01: Experimental Circuit for half wave rectifier

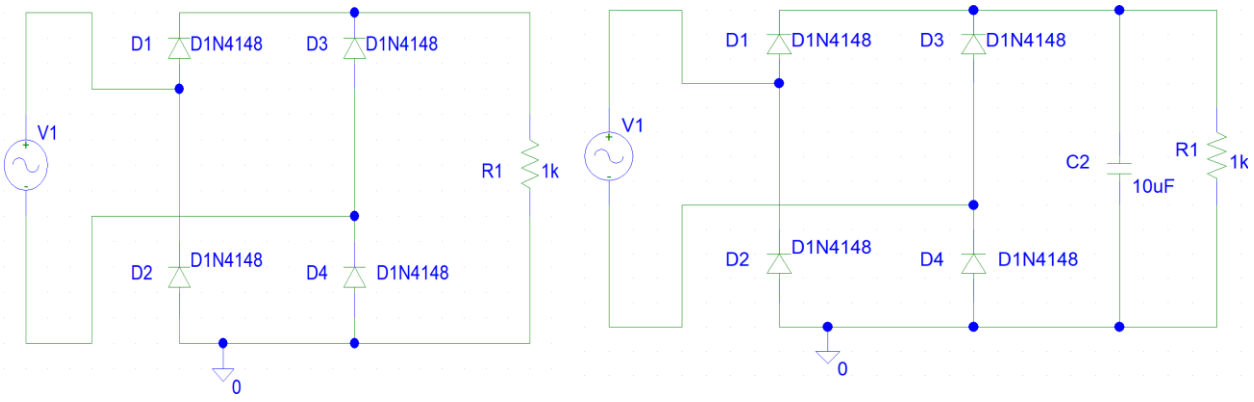

Figure 02: Experimental Circuit for full wave rectifier

Answer to the question no:01

i)Input/output voltage waveshape:

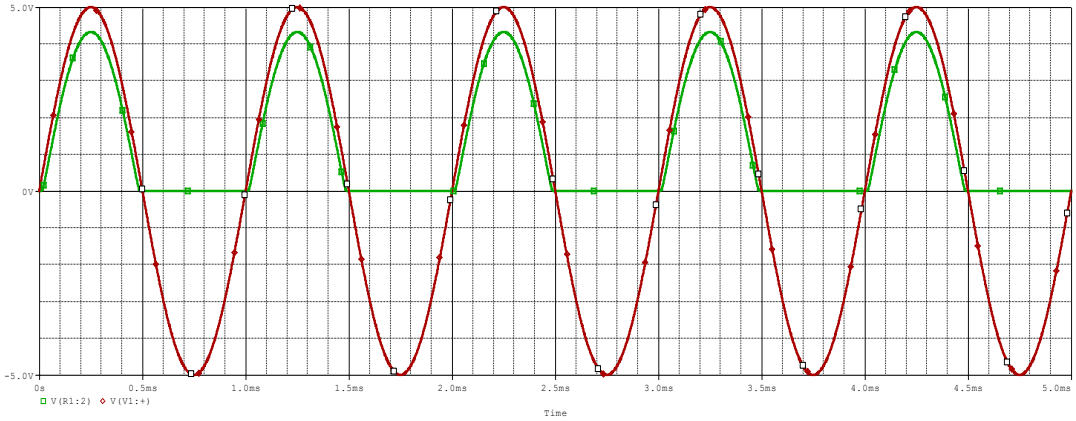

Figure 03: Waveshape of half wave rectifier without filter capacitor.

ii)Difference between output and input peak voltage:

To determine input/output voltage waveshape in PSpice, we need to find the maximum amplitude of input and output voltage.

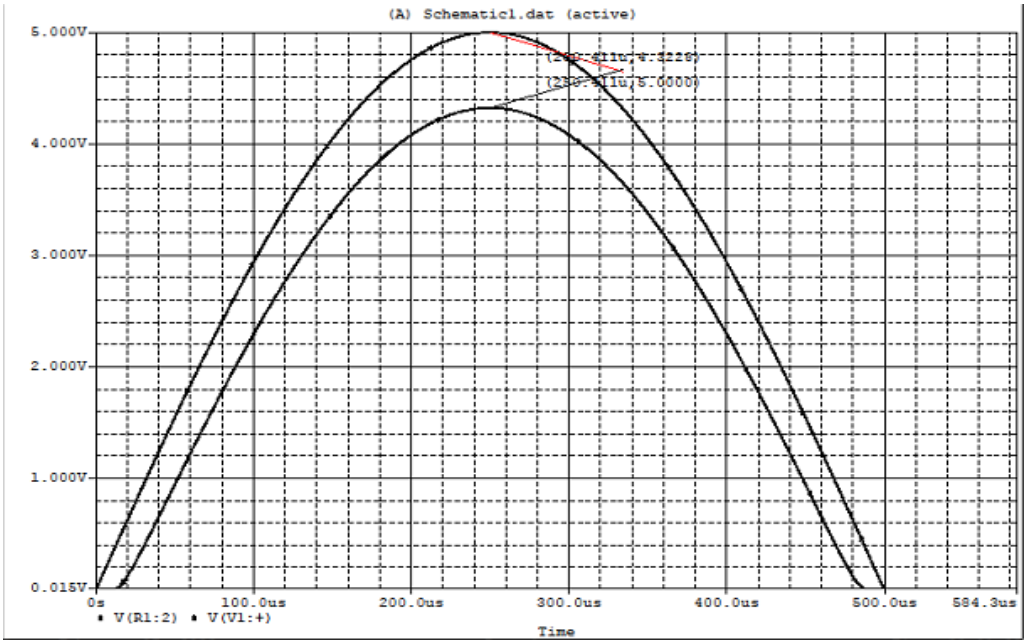

Figure 04: Waveshape of half wave rectifier without filter capacitor

Here,

$V_I = 5V$ and $V_O = 4.32V$

The Difference between output and input peak voltage is,

$(V_I - V_0) = (5 - 4.32)\ V = .68\ V \approx 0.7\ V.$

iii)<u>Time and input voltage required to turn the diode on:</u>

To turn on the diode, the input voltage should be greater than 0.7V. As silicon diode drops 0.7V, the input voltage required 0.7V to turn on the diode.

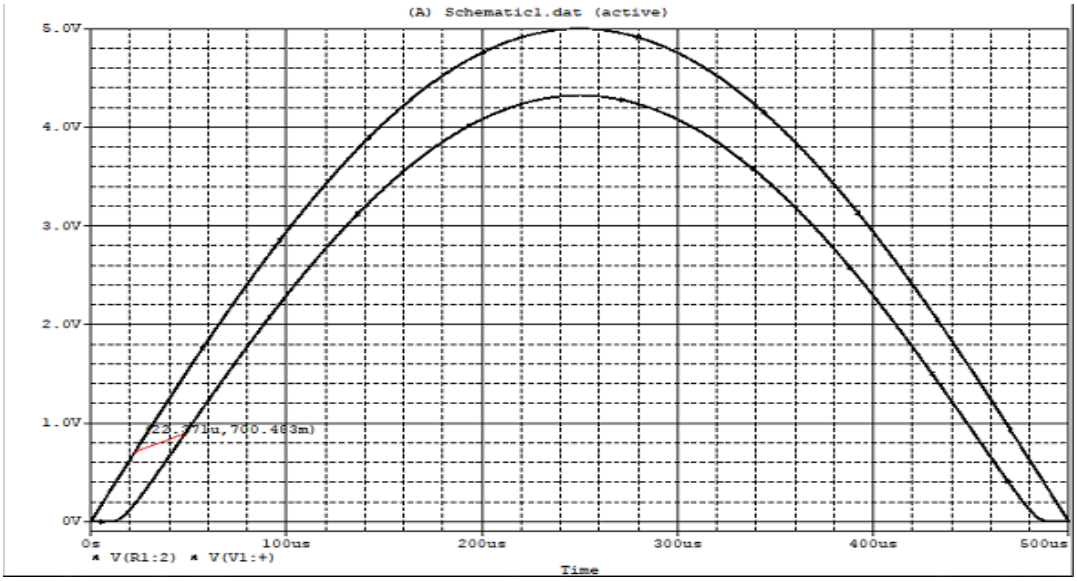

Figure 05: Waveshape of half wave rectifier without filter capacitor

From the graph, we can determine when the voltage is 0.7V the corresponding time is 22.37 us. Hence, the time is 22.37us and the input voltage is 0.7V to turn on the diode.

iv)<u>Average of output voltage</u>:

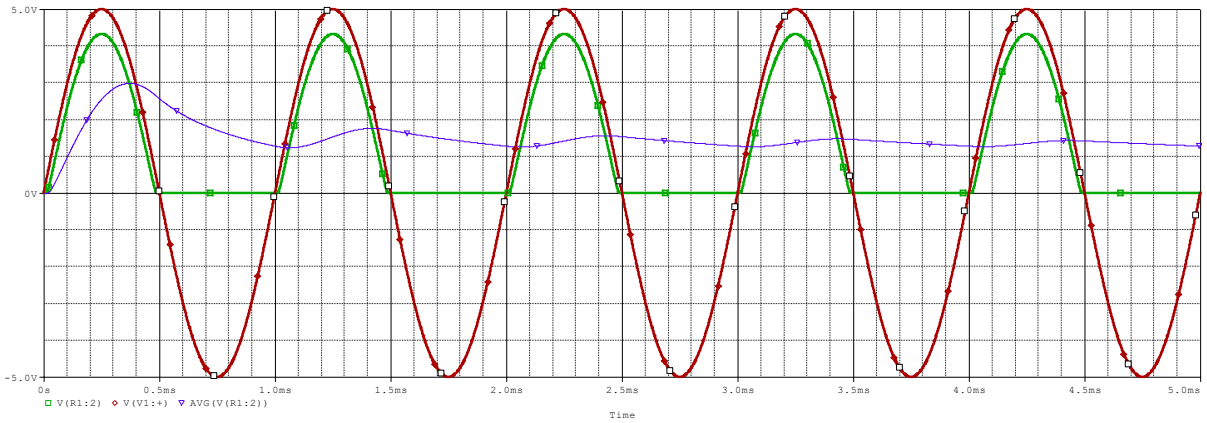

Figure 06: Waveshape of half wave rectifier without filter capacitor.

From the graph, we can determine when the average voltage is 1.3765V. we can also determine using the average voltage equation. we know for output voltage the average voltage is,

$$V_{AVG} = \frac{Vm}{\pi} V$$

$$V_{AVG} = \frac{4.32}{3.1416} V$$

$$V_{AVG} = 1.375 V$$

Therefore, the average voltage is 1.375 V.

Answer to the question no:02

i)Input/output voltage waveshape:

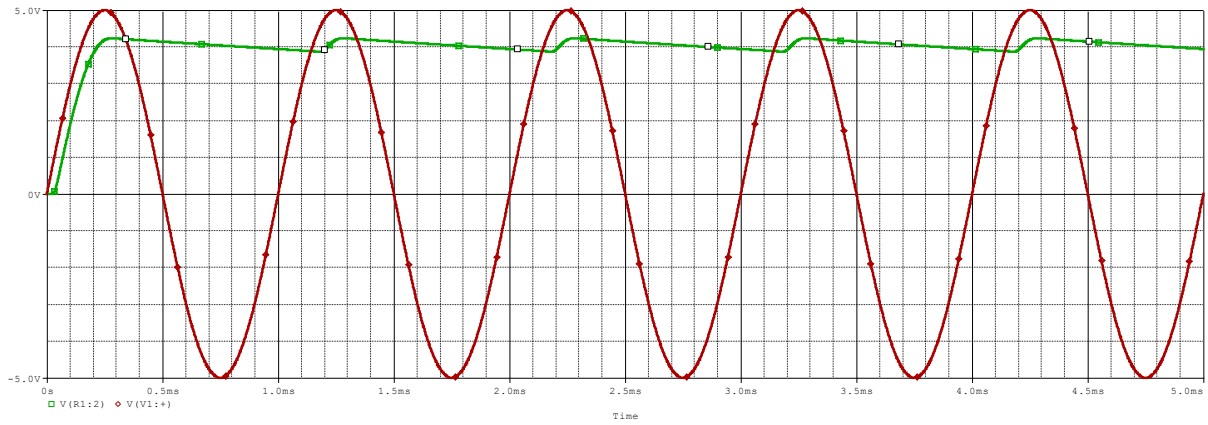

Figure 07: Waveshape of half wave rectifier with filter capacitor.

ii)Value of peak-to-peak ripple voltage: Effect of frequency and capacitor on ripple voltage:

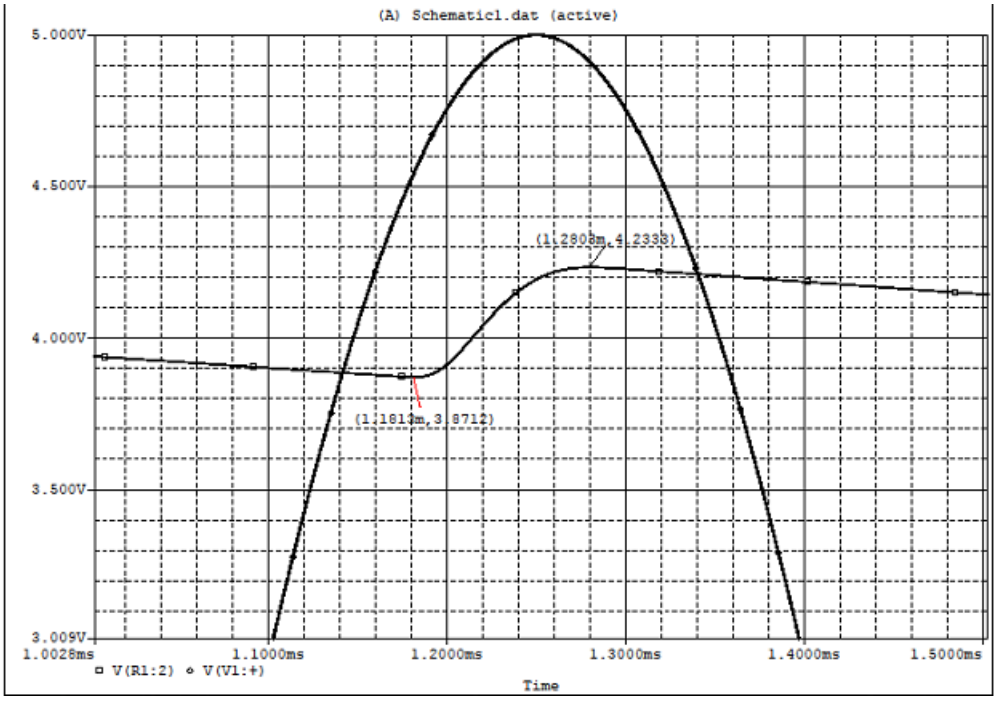

Figure 08: Waveshape of half wave rectifier with filter capacitor

From the graph we can determine,

Value of Upper peak = 4.2333 V

Value of Lower peak = 3.8712 V

So, the value of peak-to-peak ripple voltage = (4.2333-3.8712) V = 0.3621 V

The effect of frequency and capacitor on ripple voltage is in a filter, the higher the capacitance, the lower ripple voltage will be. On the other hand, the ripple voltage

will decrease as the switching frequency goes up as there is less time for the capacitor to charge or discharge between cycles and creating ripple.

iii)<u>Ripple voltage, average and maximum diode current calculation:</u>

To calculate ripple voltage we know,

$$\text{Vr} = \frac{vp}{fCR}\ \text{V}$$

$$\text{Vr} = \frac{5}{1k \times 10u \times 1k}\ \text{V}$$

$$\text{Vr} = 0.5\ \text{V}$$

To calculate average current we know,

$$\text{i}_{\text{Davg}} = \frac{Vp - (\frac{Vr}{2})}{R} \times \left(1 + \pi\sqrt{\frac{2Vp}{Vr}}\right) A$$

$$\text{i}_{\text{Davg}} = \frac{5 - (\frac{0.5}{2})}{1k} \times (1 + \pi\sqrt{\frac{2 \times 5}{0.5}})\text{A}$$

$$\text{i}_{\text{Davg}} = 0.0714\ \text{A}$$

To calculate maximum diode current we know,

$$\text{i}_{\text{Dmax}} = \frac{Vp - (\frac{Vr}{2})}{R} \times \left(1 + 2\pi\sqrt{\frac{2Vp}{Vr}}\right) A$$

$$i_{Dmax} = \frac{5-(\frac{0.5}{2})}{1k} \times (1 + 2\pi\sqrt{\frac{2\times5}{0.5}})A$$

$$i_{Dmax} = 0.13822 \text{ A}$$

Answer to the question no:03

i)Input/output voltage waveshape:

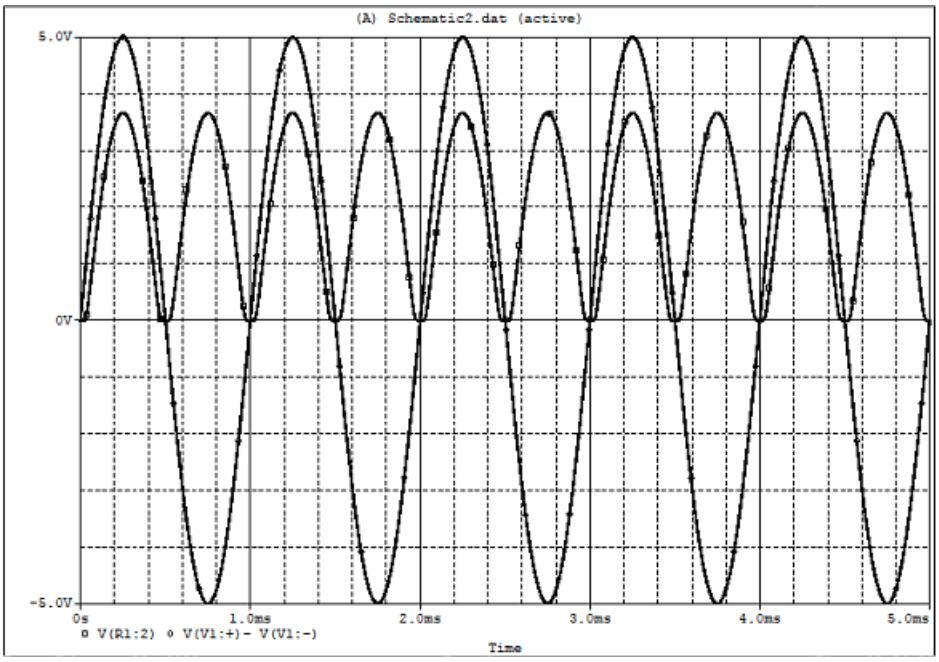

Figure 09: Waveshape of full wave rectifier without filter capacitor.

ii)Difference between output and input peak voltage:

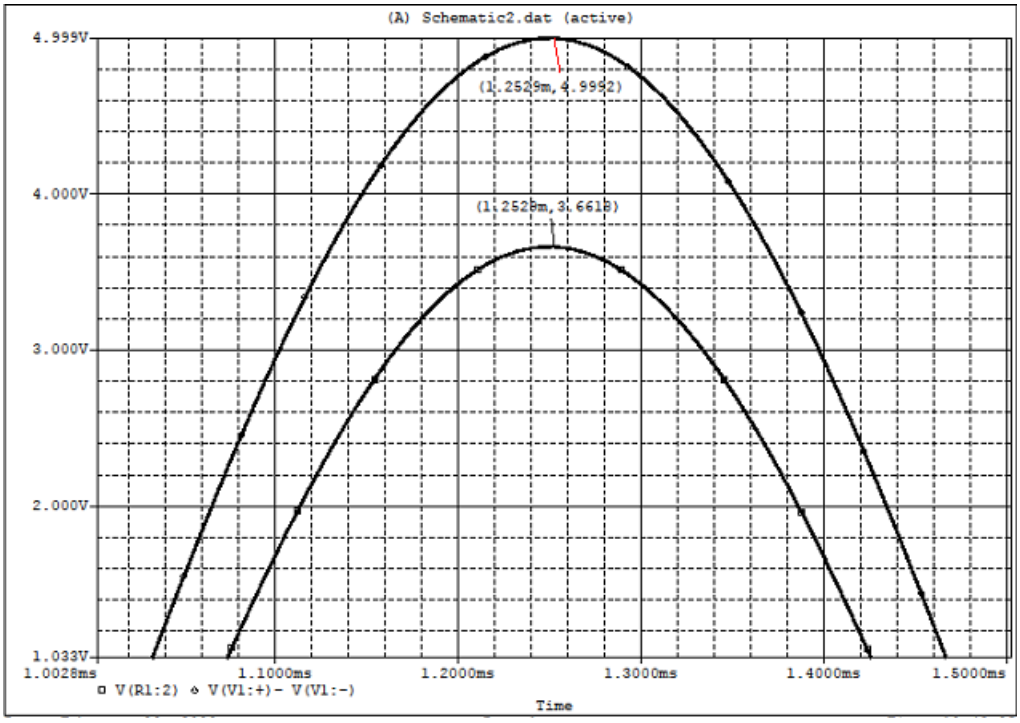

Figure 10: Waveshape of full wave rectifier without filter capacitor

From the graph, we can calculate the value of the maximum amplitude of input and output voltage,

$$V_I = 4.9992V \quad \text{and} \quad V_O = 3.6618V$$

Hence, the Difference between output and input peak voltage is $(V_I - V_0)$ = $(4.9992 - 3.6618)\ V = 1.3337\ V \approx 2\times 0.7\ V$.

iii)Time and input voltage required to turn the diode on:

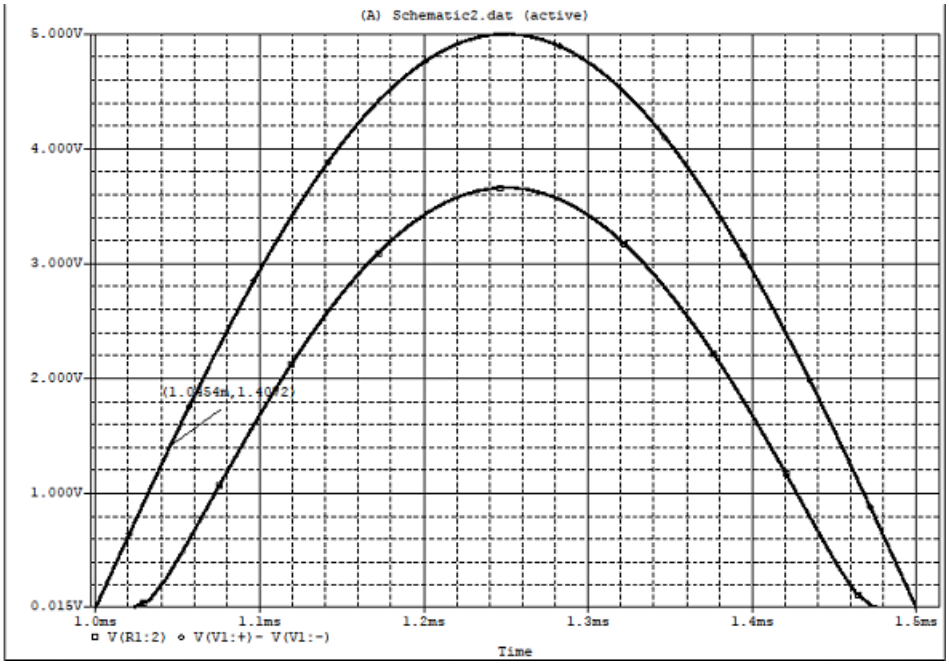

Figure 11: Waveshape of full wave rectifier without filter capacitor

To turn on the diode, the input voltage should be greater than 1.4V. As silicon diode drops 0.7V and full wave rectifier there are 2 diode drops ta voltage. So, the input voltage required (2×0.7) = 1.4V to turn on the diode. From the graph, we can determine when the voltage is 1.4V the corresponding time is 1.0454 ms. Hence, the time is 1.0454 ms and the input voltage is 1.4V to turn on the diode.

iv)Average of output voltage:

To calculate average current we know,

$$V_{AVG} = \frac{2Vm}{\pi} V$$

$$V_{AVG} = \frac{2\times3.6618}{3.1416} V$$

$$V_{AVG} = 2.331 V$$

Answer to the question no: 04

i)Input/output voltage waveshape:

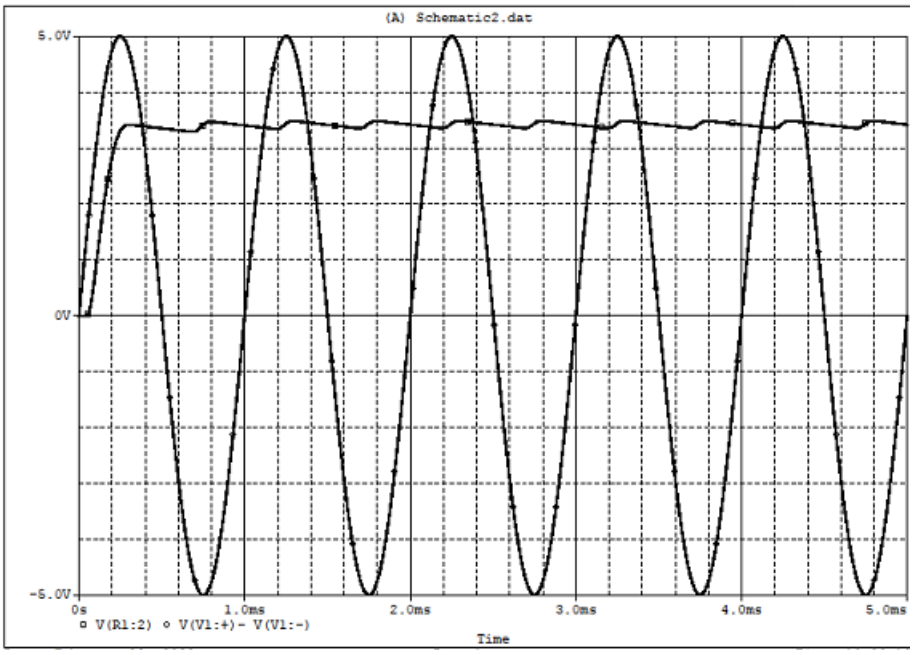

Figure 12: Waveshape of full wave rectifier with filter capacitor.

ii)Value of peak-to-peak ripple voltage: Effect of frequency and capacitor on ripple voltage:

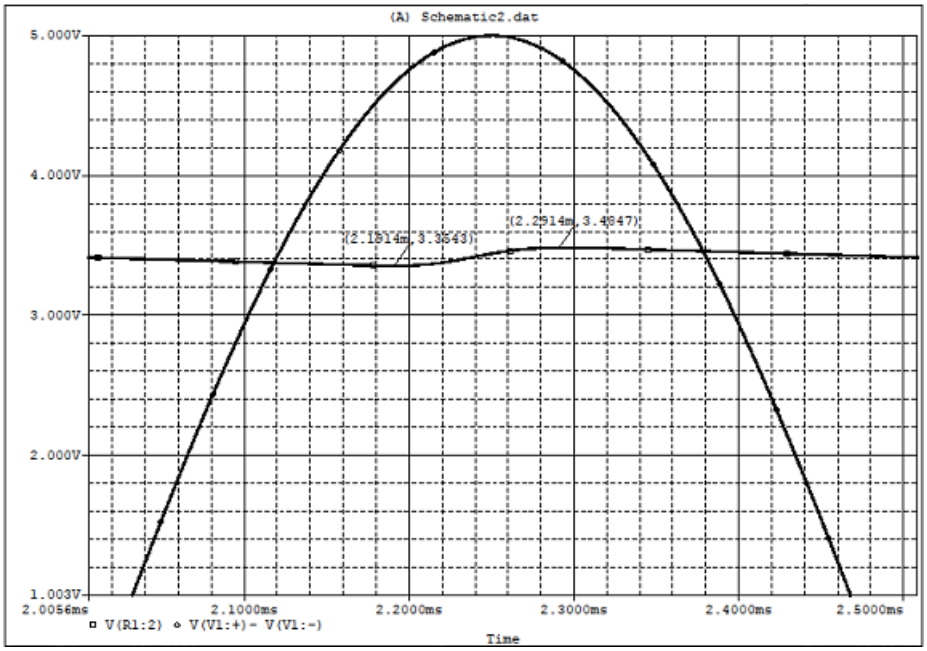

Figure 13: Waveshape of full wave rectifier with filter capacitor

From the graph we can determine,

Value of High peak = 3.4847 V

Value of Low peak = 3.3543 V

So, the value of peak-to-peak ripple voltage = (3.4847-3.3543) V = 0.1304 V

The effect of frequency and capacitor on ripple voltage is in a filter, the higher the capacitance, the lower ripple voltage will be. On the other hand, the ripple voltage

will decrease as the switching frequency goes up as there is less time for the capacitor to charge or discharge between cycles and creating ripple.

iii)<u>Ripple voltage, average and maximum diode current calculation:</u>

To calculate ripple voltage we know,

$$Vr = \frac{vp}{2fCR}\ V$$

$$Vr = \frac{5}{2\times 1k\times 10u\times 1k}\ V$$

$$Vr = 0.25\ V$$

To calculate average current, first we have to calculate the output average voltage we know,

$$V_0 = Vp - (\frac{Vr}{2})$$

Here, Vp is the maximum amplitude of output voltage which is 3.415V. So,

$$V_0 = 3.415 - (\frac{0.25}{2})\ V$$

$$V_0 = 3.29\ V$$

Now,

$$I_L = \frac{V0}{R}$$

$$I_L = \frac{3.29}{1k}\ A$$

$$I_L = 3.29\ mA$$

Hence, the average current,

$$i_{Davg} = IL \times \left(1 + \pi\sqrt{\frac{2Vp}{Vr}}\right)A$$

$$i_{Davg} = 3.29\ m \times (1 + \pi\sqrt{\frac{2\times3.415}{0.25}})A$$

$$i_{Davg} = 0.0573\ A$$

To calculate maximum diode current we know,

$$i_{Dmax} = IL \times \left(1 + 2\pi\sqrt{\frac{2Vp}{Vr}}\right)A$$

$$i_{Dmax} = 3.29\ m \times (1 + 2\pi\sqrt{\frac{2\times3.415}{0.25}})A$$

$$i_{Dmax} = 0.1113\ A$$

Conclusion:

The lab is performed virtually through simulation using PSpice, the experiments were much easier to carry out because the magnitudes were not disrupted. As a result, there was no difference between the theoretical and experimental values. If the experiment was done physically then there would be some discrepancy.