1.

CSE251

Electronic Devices and Circuits

Exp-02: Study of Half-Wave and Full-Wave Diode Rectifier Circuit

Submitted By:

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Semester: Fall 22

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Date of Performance: 10/10/22

Date of Submission: 16/10/22

2.
Average RMS for HW=Vm/π =1.579V
Effective RMS for HW=Vm/2 =2.480V
The values are similar to those obtained in the multimeter.

Average RMS for FW=2Vm/π =3.158V
Effective RMS for FW= Vm/√2 =3.507V
The values are larger than those obtained in the multimeter.

3. Data Table

		Experimental Observation			Theoretical Calculation		
	C(uF)	**Vr-rms (V)**	**Vdc (V)**	**Ripple Factor**	**Vr-rms (V)**	**Vdc (V)**	**Ripple Factor**
HW	**1**	**0.690**	**3.20**	**0.216**	**0.647**	**3.28**	**0.197**
	4.7	**0.224**	**3.93**	**0.0570**	**0.208**	**3.96**	**0.0525**
FW	**1**	**0.328**	**3.36**	**0.0976**	**0.323**	**3.40**	**0.0950**
	4.7	**0.091**	**3.63**	**0.0251**	**0.104**	**3.62**	**0.0287**

4. Circuit Diagrams:

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Circuit Diagrams:

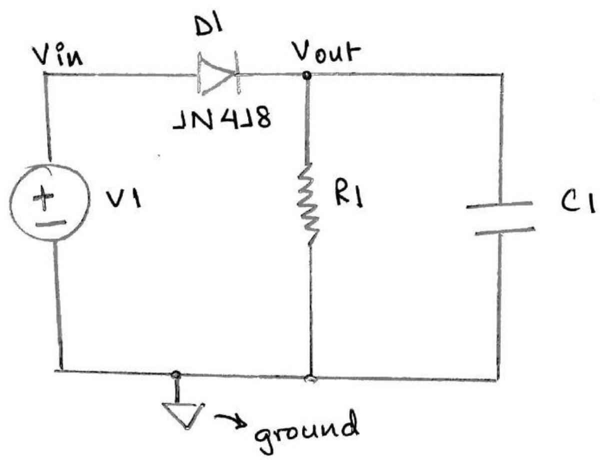


Figure: Half Wave Rectifier Circuit

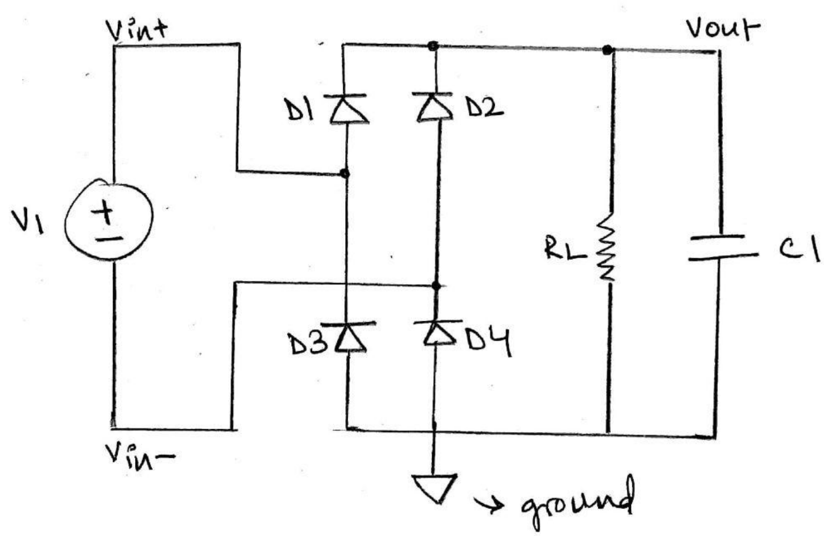
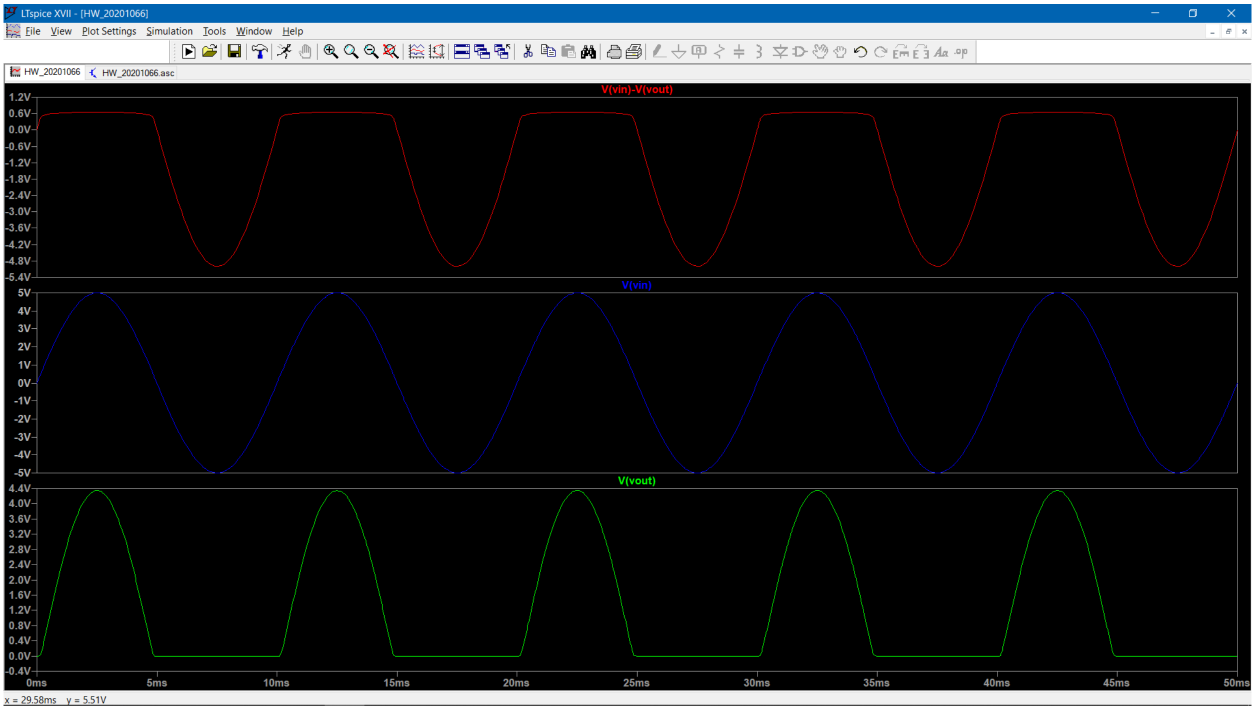
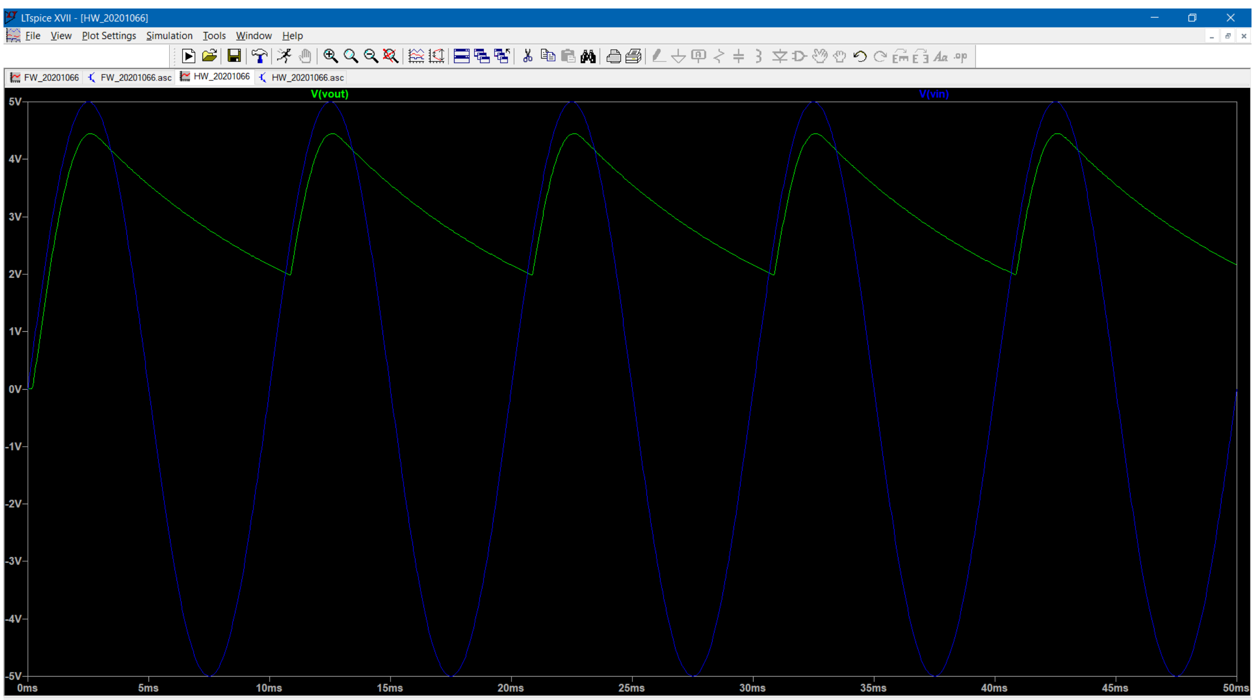
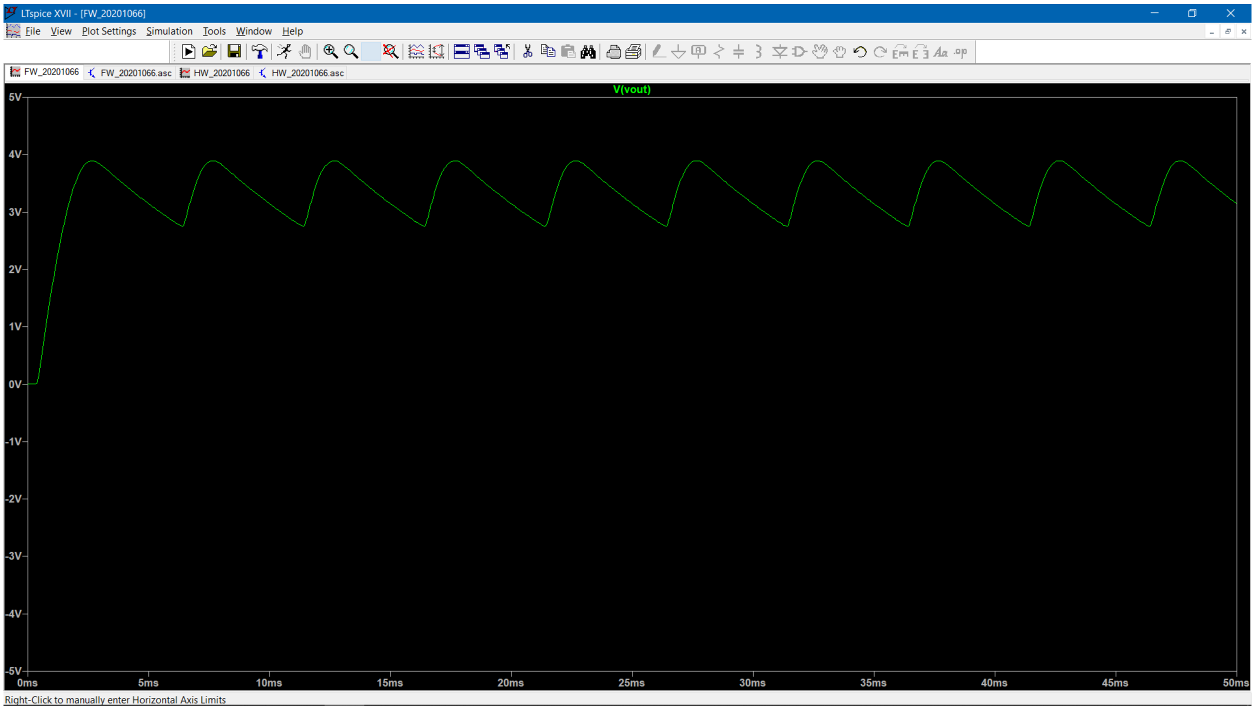


Figure: Full Wave Rectifier Circuit

5. Waveform Traces



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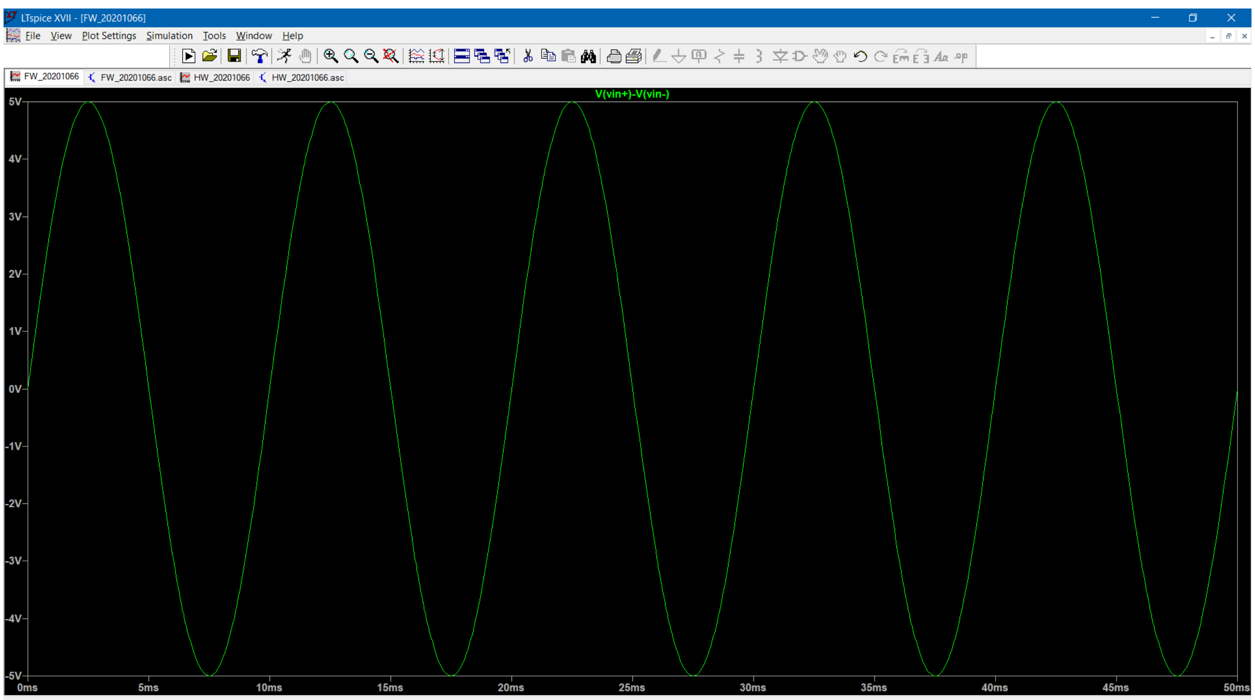
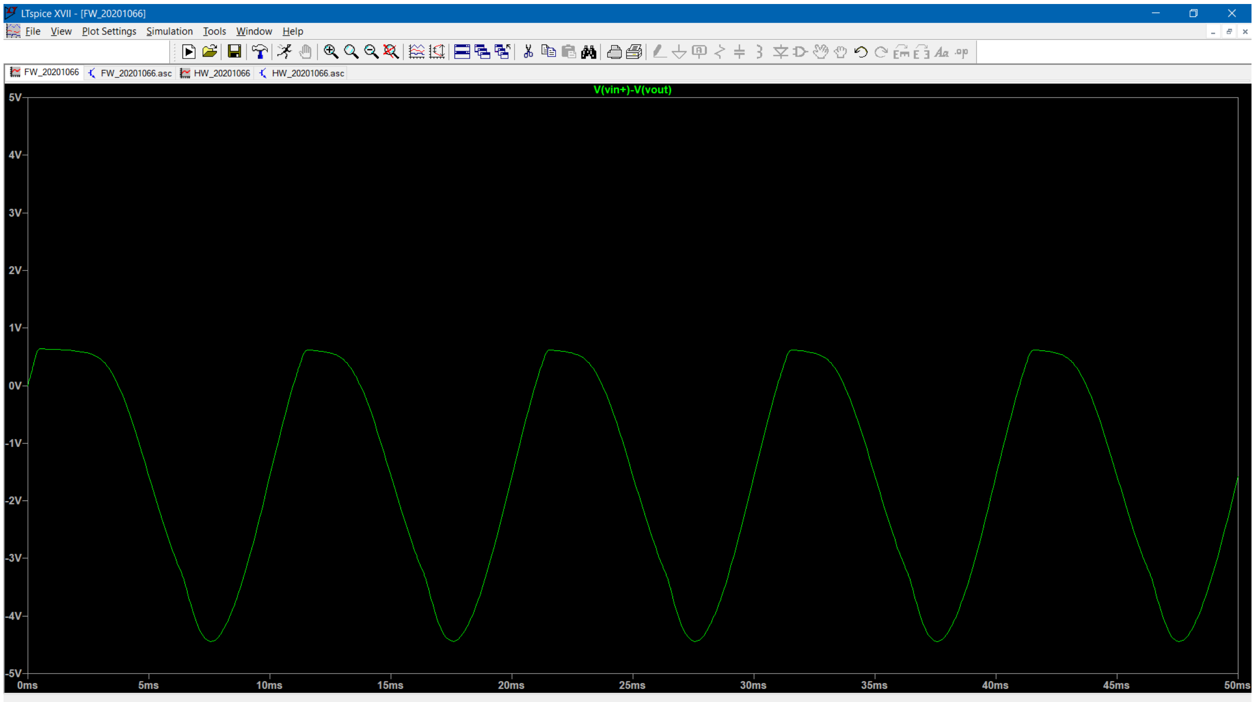
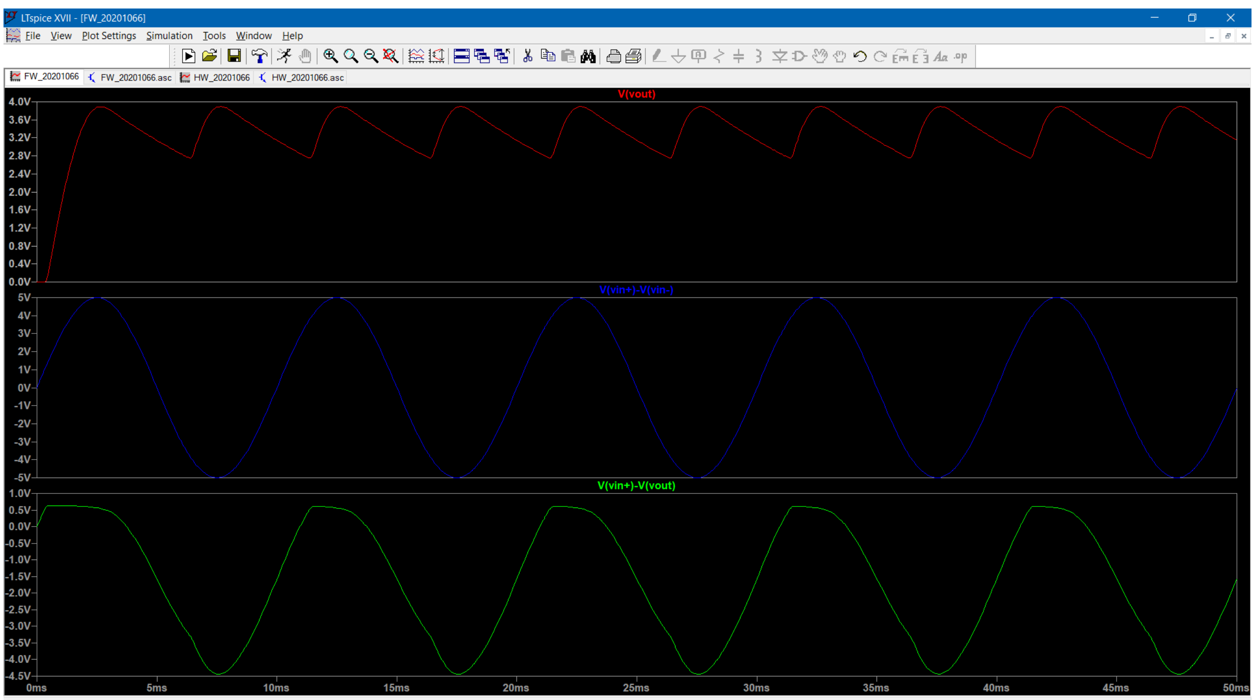
File View Plot Settings Simulation Tools Window Help
FW_20201066 FW_20201066.asc HW_20201066 HW_20201066.asc
V(vout)
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0ms 5ms 10ms 15ms 20ms 25ms 30ms 35ms 40ms 45ms 50ms
Right-Click to manually enter Horizontal Axis Limits


LTspice XVII - [FW_20201066]
File View Plot Settings Simulation Tools Window Help
FW_20201066 FW_20201066.asc HW_20201066 HW_20201066.asc
V(vin+)-V(vin-)
5V
4V
3V
2V
1V
0V
-1V
-2V
-3V
-4V
-5V
0ms 5ms 10ms 15ms 20ms 25ms 30ms 35ms 40ms 45ms 50ms
x = 21.18ms y = 2.50V


LTspice XVII - [FW_20201066]
File View Plot Settings Simulation Tools Window Help
FW_20201066 FW_20201066.asc HW_20201066 HW_20201066.asc
V(vin+)-V(vout)
5V 4V 3V 2V 1V 0V -1V -2V -3V -4V -5V
0ms 5ms 10ms 15ms 20ms 25ms 30ms 35ms 40ms 45ms 50ms


LTspice XVII - [FW_20201066]
File View Plot Settings Simulation Tools Window Help
FW_20201066 FW_20201066.asc HW_20201066 HW_20201066.asc
V(vout)
4.0V 3.6V 3.2V 2.8V 2.4V 2.0V 1.6V 1.2V 0.8V 0.4V 0.0V
V(vin+)-V(vin-)
5V 4V 3V 2V 1V 0V -1V -2V -3V -4V -5V
V(vin+)-V(vout)
1.0V 0.5V 0.0V -0.5V -1.0V -1.5V -2.0V -2.5V -3.0V -3.5V -4.0V -4.5V
0ms 5ms 10ms 15ms 20ms 25ms 30ms 35ms 40ms 45ms 50ms
Right-Click to manually enter Horizontal Axis Limits

6. Data Sheet

Lab Group: ....05.......   Student ID: ...20201066,...20101443,...21301610,...21301611

Experimental Observation

1. **HW Rectifier without Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 4.96V
   Average or DC output voltage, V_{dc} (multimeter in DC mode) = 1.31 V
   RMS or AC output voltage, V_{r-rms} (multimeter in AC mode) = 1.70V

2. **HW Rectifier with 1μF Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 4.40V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (oscilloscope) = 2.24V
   Average or DC value of the ripple voltage, V_{dc} (multimeter in DC mode) = 3.20V
   RMS or AC value of the ripple voltage, V_{r-rms} (multimeter in AC mode) = 0.690V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = 0.216

3. **HW Rectifier with 4.7μF Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 4.32V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (oscilloscope) = 0.72V
   Average or DC value of the ripple voltage, V_{dc} (multimeter in DC mode) = 3.93V
   RMS or AC value of the ripple voltage, V_{r-rms} (multimeter in AC mode) = 0.224V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = 0.0570

Theoretical Calculation (Homework)

1. **HW Rectifier Without Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 4.96V
   Peak input voltage, V_m = 4.96V
   Diode voltage, V_{D0} = 0.7 V
   DC output voltage of the rectifier, $V_{dc} = \frac{V_m}{\pi} - \frac{V_{D0}}{2}$ = 1.229 V
   RMS or AC output voltage, $V_{r-rms} = \frac{V_p}{2}$ = 2.48V

2. **HW Rectifier With 1μF Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 4.40V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (see the experimental observation)= 2.24V
   DC value of the ripple voltage, $V_{dc} = V_p - \frac{V_{r(p-p)}}{2}$ = 3.28V
   RMS value of the ripple voltage, $V_{r-rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$ = 0.647V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = 0.197

3. **HW Rectifier with 4.7μF Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 4.32V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (see the experimental observation) = 0.72V
   DC value of the ripple voltage, $V_{dc} = V_p - \frac{V_{r(p-p)}}{2}$ = 3.96V
   RMS value of the ripple voltage, $V_{r-rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$ = 0.208V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = 0.0525

Task-02: FW Rectifier

Procedure

1. Construct circuit of Figure 6 without the capacitor. Observe V_s and V_o separately on the oscilloscope [i.e use only one channel].
2. Save the input and output waveforms in your memory stick, or sketch the waveforms on a tracing paper.
3. Measure V_o with a multimeter in dc and ac mode.
4. Connect 1μF capacitor across the load resistor, R_L (BE CAREFUL about the polarity of the capacitor).
5. Save the output waveform in your memory stick, or sketch the waveform on a tracing paper.
6. Measure the peak voltage of the output, V_p and peak-to-peak ripple voltage $V_{r(p-p)}$ from the oscilloscope (To measure the peak and the ripple voltages, go to the "measure" tab of the oscilloscope or switch on the cursors of the oscilloscope. This allows you to level your cursor horizontally with the peak or the ripple voltage and measure the values).

7. Also measure V_o with a multimeter in dc and ac mode and calculate the ripple factor.

8. Replace 1μF Capacitor with 4.7μF and repeat steps 4-7.

Experimental Observation

1. **FW Rectifier without Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 4.0V
   Average or DC output voltage, V_{dc} (multimeter in DC mode) = 2.26V
   RMS or AC output voltage, V_{r-rms} (multimeter in AC mode) = 1.36V

2. **FW Rectifier with 1μF Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 3.96V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (oscilloscope) = 1.12V
   Average or DC value of the ripple voltage, V_{dc} (multimeter in DC mode) = 3.36V
   RMS or AC value of the ripple voltage, V_{r-rms} (multimeter in AC mode) = 0.328V
   Ripple factor, r = V_{r-rms}/V_{dc} = 0.0976

3. **FW Rectifier with 4.7μF Capacitor:**
   Peak output voltage, V_p (oscilloscope) = 3.80V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (oscilloscope) = 0.36V
   Average or DC value of the ripple voltage, V_{dc} (multimeter in DC mode) = 3.63V
   RMS or AC value of the ripple voltage, V_{r-rms} (multimeter in AC mode) = 0.091V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = 0.0251

Theoretical Calculation (Homework)

1. **FW Rectifier without Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 4.0V
   Peak input voltage, V_m = 4.96V
   Diode voltage, V_{D0} = 0.7 V
   DC output voltage of the rectifier, $V_{dc} = \frac{2V_m}{\pi} - 2V_{D0}$ = 1.758V
   RMS or AC output voltage, $V_{r-rms} = \frac{V_p}{\sqrt{2}}$ = 2.828V

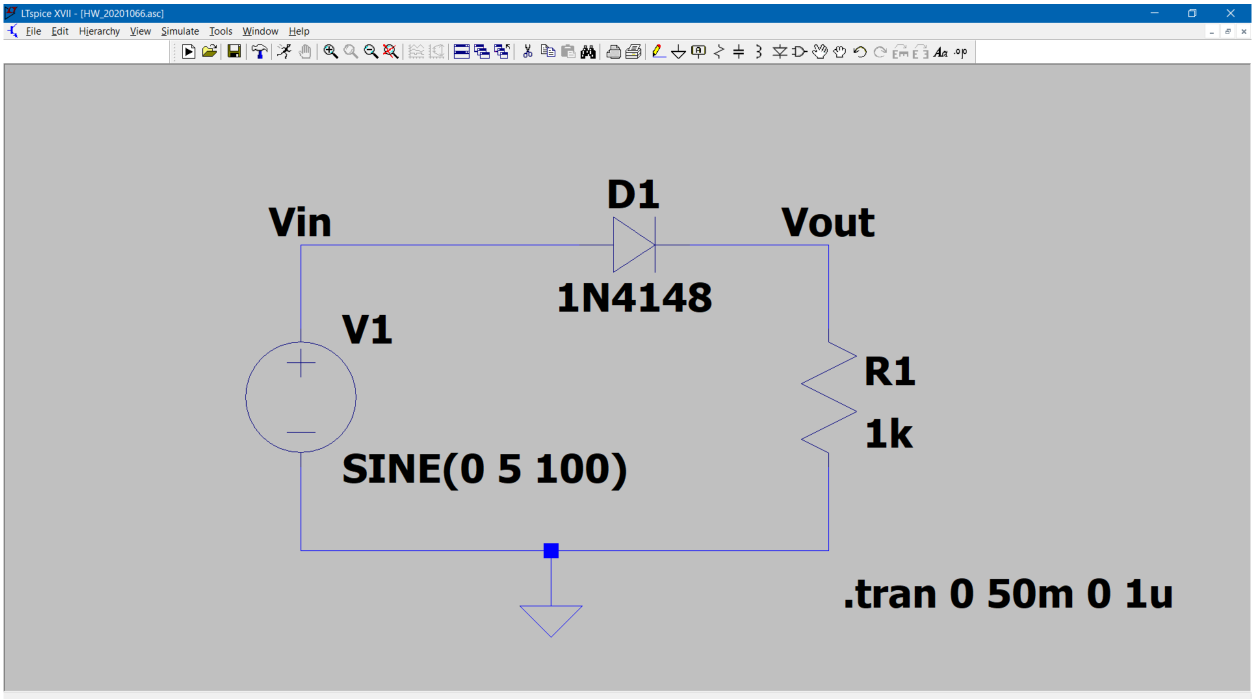
2. **FW Rectifier with 1μF Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 3.96V
   Peak to peak ripple voltage, $V_{r(p-p)}$ (see the experimental observation) = 1.12V
   DC value of the ripple voltage, $V_{dc} = V_p - \frac{V_{r(p-p)}}{2}$ = 3.40V
   RMS value of the ripple voltage, $V_{r-rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$ = 0.323V
   Ripple factor, $r = V_{r-rms}/V_{dc}$ = ~~0.09~~ 0.0950

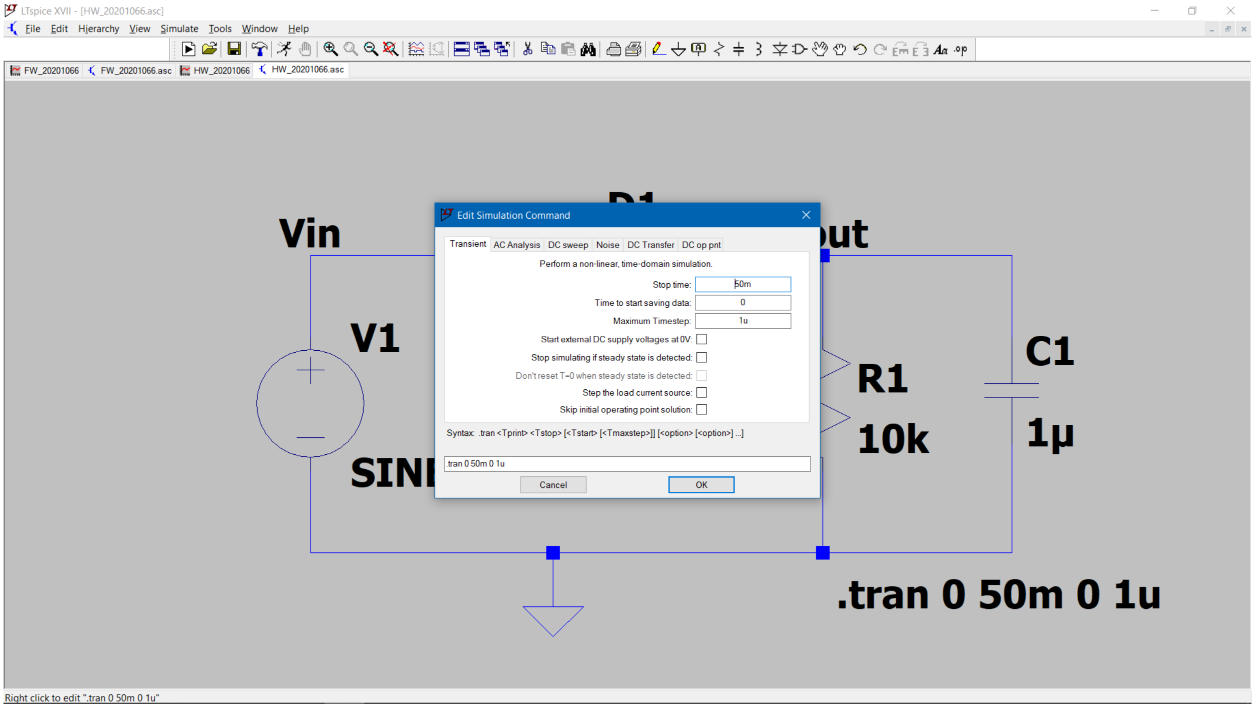
3. **FW Rectifier with 4.7μF Capacitor:**
   Peak output voltage, V_p (see the experimental observation) = 3.80V
   Peak to peak ripple voltage, V_p (see the experimental observation) = 0.36V
   DC value of the ripple voltage, $V_{dc} = V_p - \frac{V_{r(p-p)}}{2}$ = 3.62V
   RMS value of the ripple voltage, $V_{r-rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$ = 0.104 V
   Ripple factor, r = V_{r-rms}/V_{dc} = 0.0287

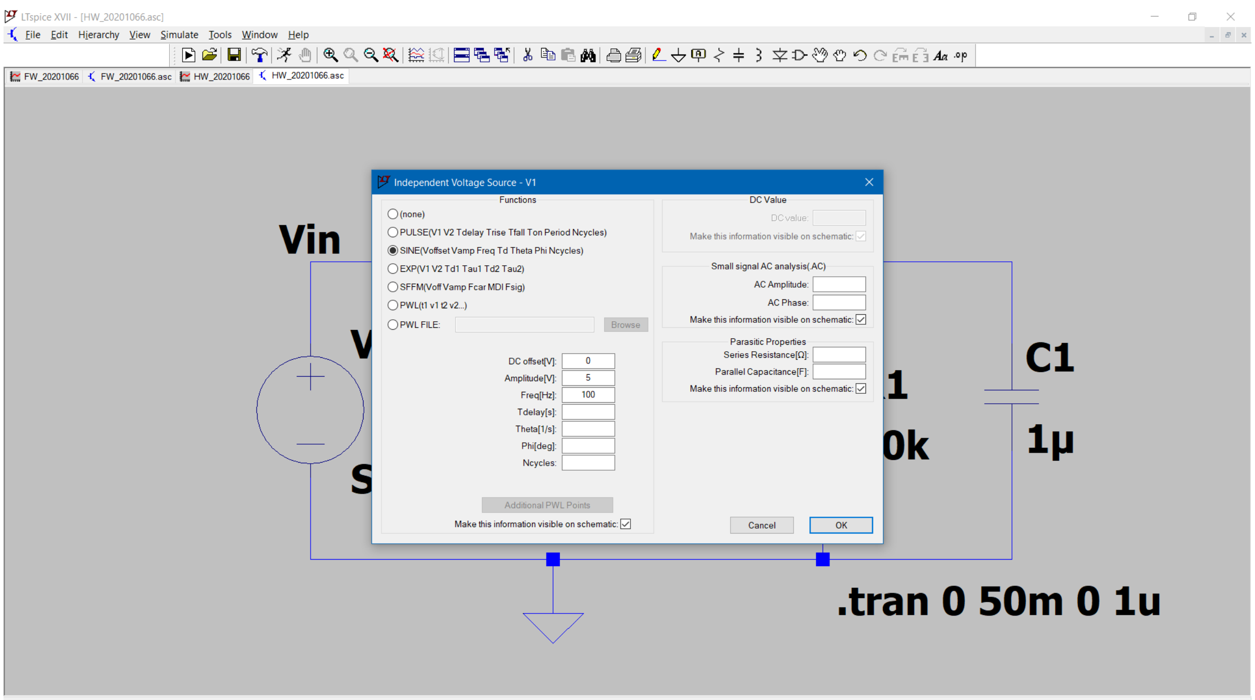
10-10-22

7.

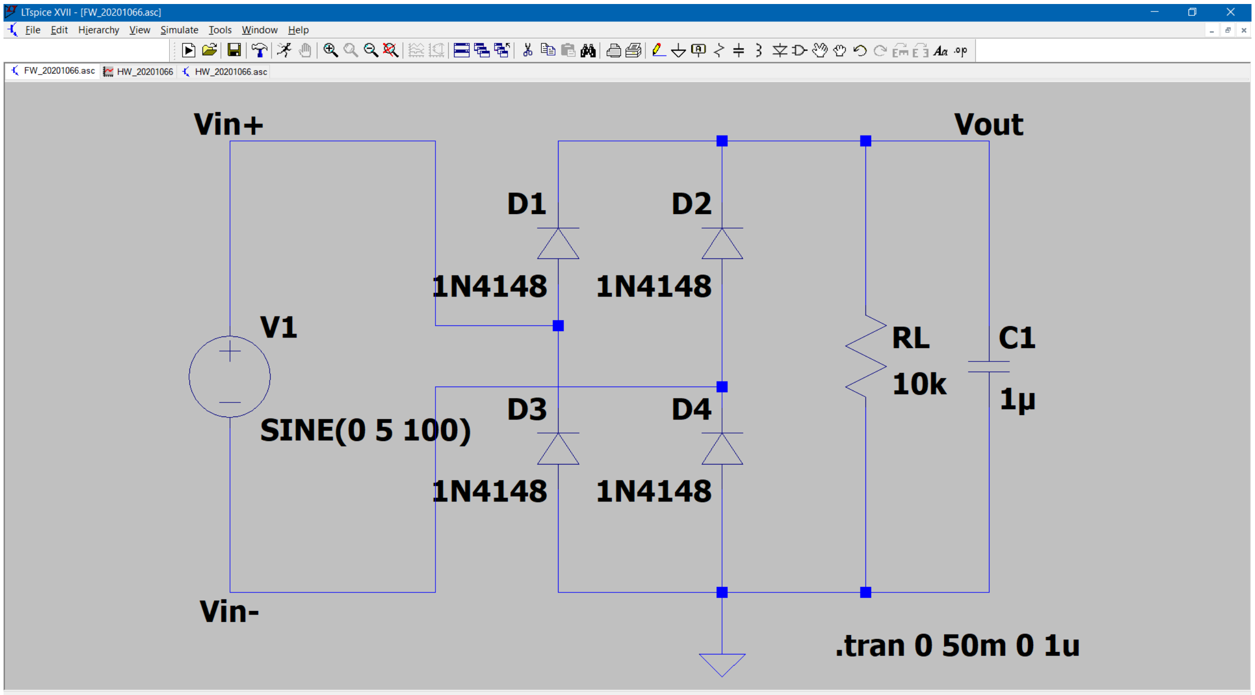
Schematic Diagram for HW:







Schematic Diagram for FW: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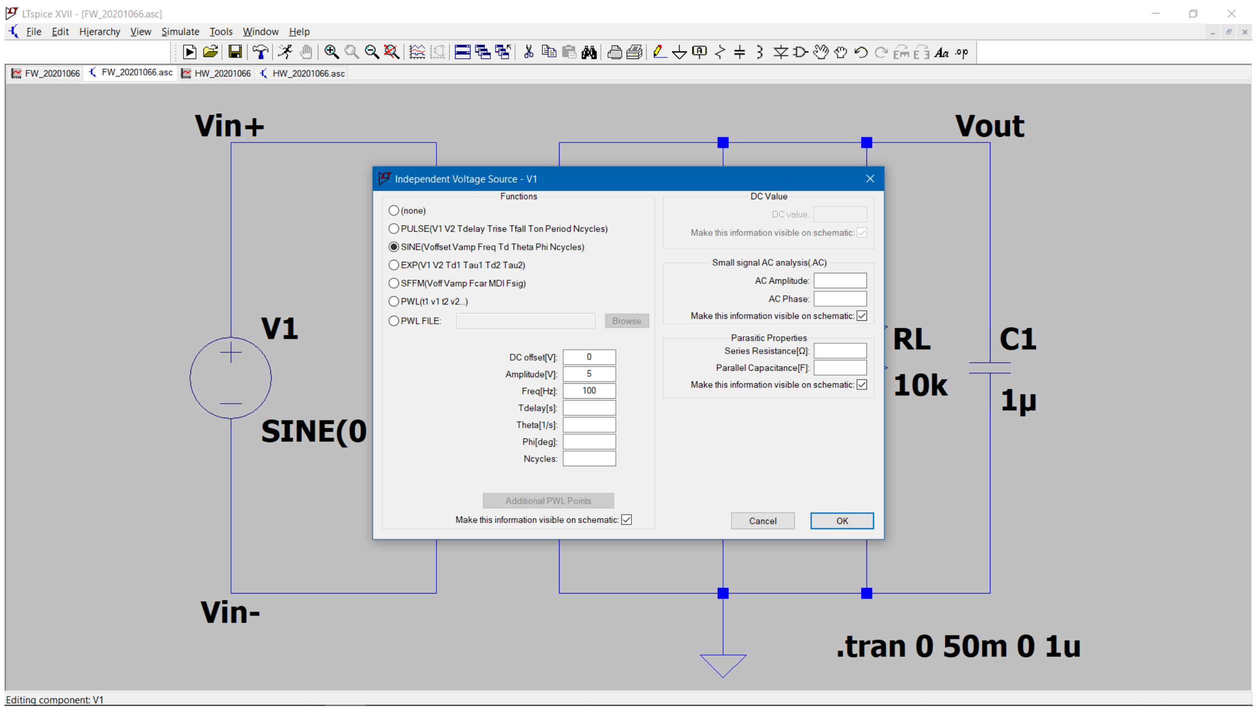
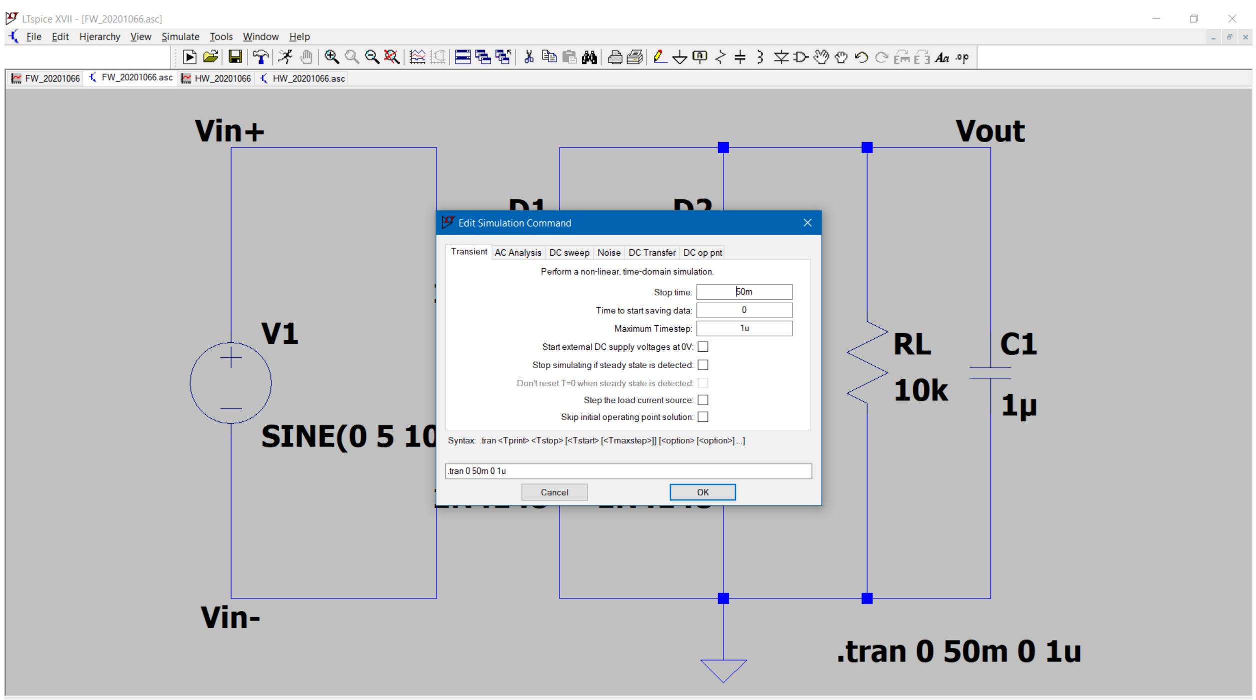
FW_20201066.asc
HW_20201066
HW_20201066.asc
Vin+
Vout
D1
D2
1N4148
1N4148
V1
RL
C1
10k
1µ
D3
D4
SINE(0 5 100)
1N4148
1N4148
Vin-
.tran 0 50m 0 1u





8. Discussion

The 4.7uF capacitor acts as a better filter as ripple voltage is lower and DC voltage is higher. Ripple factor is also very low.

The Full-Wave Rectifier is better than the Half-Wave Rectifier because the average output voltage is higher in a Full-Wave Rectifier, there is less ripple voltage produced in the Full-Wave Rectifier when compared to the Half-Wave Rectifier.
Both channels were not used simultaneously because an oscilloscope has ground inputs inside, and connecting both channels directly would short out some parts of the rectifier bridge.

Challenges faced during the experiment was primarily arranging the circuit on the breadboard properly for the FW Rectifier and calibrating the oscilloscope to generate the correct waveform for the voltages,