EE236: Experiment 0
Ngspice Usage and Examples

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1 Overview of the experiment

This report contains my approach to the experiment, the circuit's design with the relevant simulation code and output waveforms.

1.1 Aim of the experiment

- To get familiar with Ngspice, XCircuit and LaTeX.
- To understand and simulate Shunt Clipper and it's variations.
- To understand and simulate Diode-based Bridge Rectifier circuit.

1.2 Methods

First, I revised and understood the working of shunt clippers. Then I went through the given shunt clipper example and its code. Using this I completed the first part.
Secondly, I studied Bridge Rectifier concepts and designed a reduced diode-based model.
My goal was to simulate these circuits, verify their outputs intuitively and include my observations in this report.

2 Design

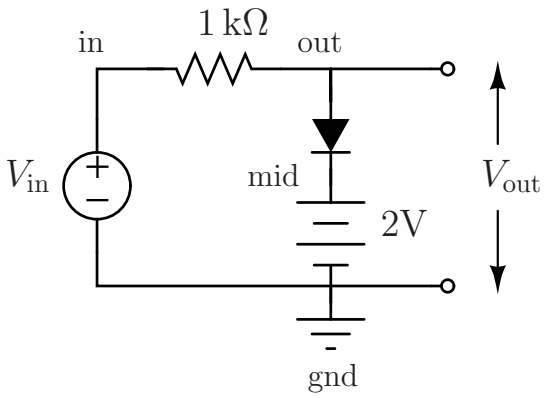
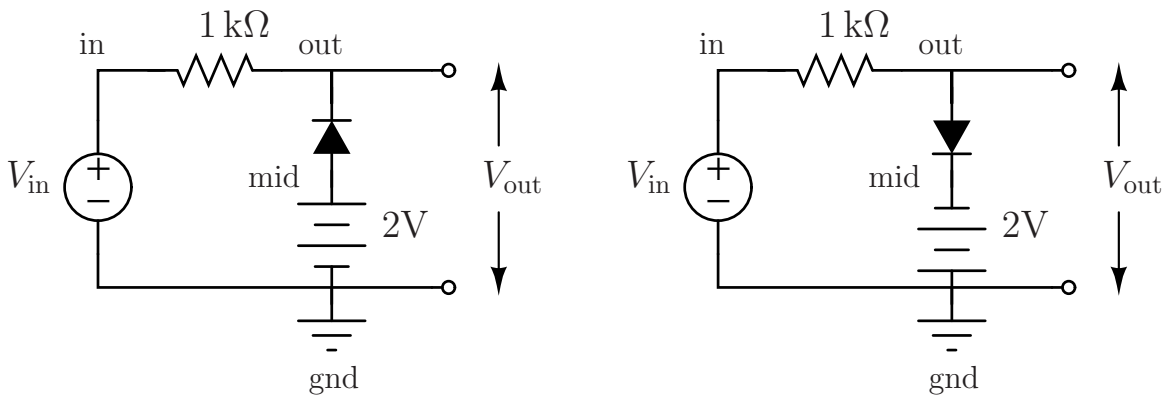


Figure 1: Shunt Clipper (Given)

For the first question, the circuits were designed after modifying the given circuit (Fig 1).
Diode connections were changed to get the circuit shown in Fig 2a.
Battery Polarity was reversed to get the circuit shown in Fig 2b.
In all the cases, 1 kΩ resistor was used.



(a) Diode Reversed (b) Battery Polarity Reversed

Figure 2: Modified Shunt Clipper

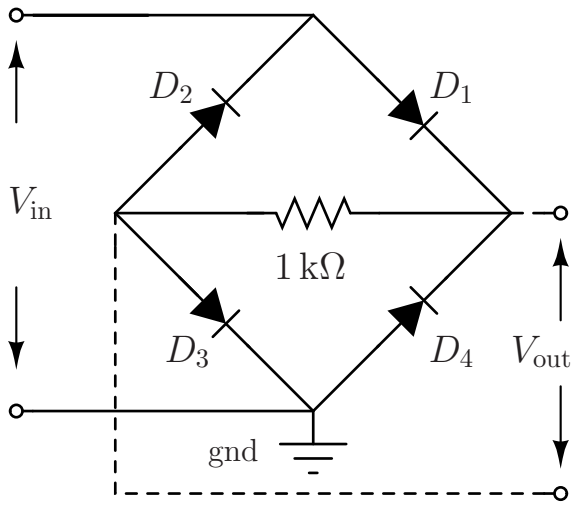


Figure 3: Diode-Based Bridge Rectifier

The diode-based Bridge Rectifer circuit was simplified and elements like Transfomers were removed for the purpose of simpler simulation. This also made it easier to provide input and measure output across the resistor. The resistance was 1 kΩ across the output terminals.
The key design here is the arrangement of four diodes as shown in Figure 3

3 Simulation results

3.1 Code snippets

3.1.1 Shunt Clipper Transient analysis with reverse diode connections

```
Param Rathour (190070049), Shunt Clipper reverse diode connections

.include Diode_1N914.txt   ; Includes Diode Model
R1 out in 1k               ; Resistor (assumed 1k)
D1 mid out 1N914           ; Diode
Vdc mid gnd dc 2           ; Independent DC source
Vin in gnd sin(0 5 1k 0 0) ; AC source Vin
.tran 0.01m 6m             ; Transient Analysis
.control
run
plot V(in) V(out)
plot V(out) vs V(in)

hardcopy 1a1.eps V(in) V(out)
hardcopy 1a2.eps V(out) vs V(in)
.endc
.end
```

3.1.2 Shunt Clipper Transient analysis with reverse battery polarity

```
Param Rathour (190070049), Shunt Clipper reverse battery polarity

.include Diode_1N914.txt   ; Includes Diode Model
R1 out in 1k               ; Resistor (assumed 1k)
D1 out mid 1N914           ; Diode
Vdc mid gnd dc -2          ; Independent DC source
Vin in gnd sin(0 5 1k 0 0) ; AC source Vin
.tran 0.01m 6m             ; Transient Analysis
.control
run
plot V(in) V(out)
plot V(out) vs V(in)

hardcopy 1b1.eps V(in) V(out)
hardcopy 1b2.eps V(out) vs V(in)
.endc
.end
```

3.1.3 Diode-Based Bridge Rectifier

```
Param Rathour (190070049), Diode-Based Bridge Rectifier

.include Diode_1N914.txt            ; Includes Diode Model
Vin in gnd sin(0 16.9705627 50 0 0) ; Source Vin

D1 in outp 1N914                     ; Diode
D2 outn in 1N914                     ; Diode
D3 outn gnd 1N914                    ; Diode
D4 gnd outp 1N914                    ; Diode
RL outp outn 1k                       ; Resistor (assumed 1k)

.tran 0.01m 0.12                     ; Transient Analysis
.control
run
plot V(in) {V(outp) - V(outn)}
plot {V(outp) - V(outn)} vs V(in)

hardcopy 21.eps V(in) {V(outp) - V(outn)}
hardcopy 22.eps {V(outp) - V(outn)} vs V(in)
.endc
.end
```

3.1.4 Code for Ngspice plots

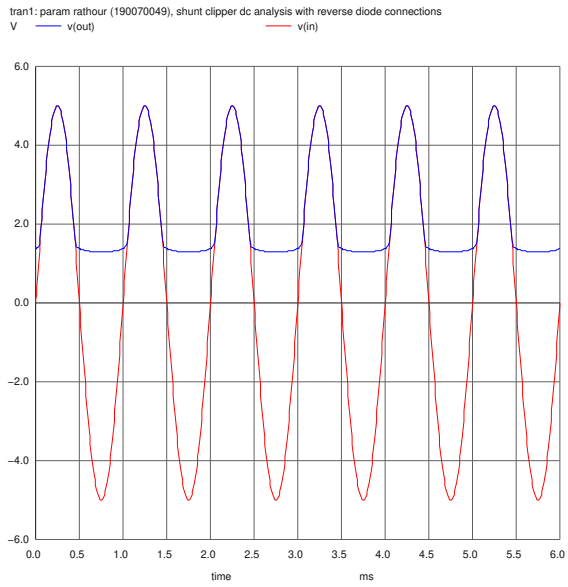
```
set hcopydevtype = postscript
set hcopypscolor = 0
set color0 = rgb:f/f/f
set color1 = rgb:/1/1/1
set color2 = rgb:f/0/0
set color3 = rgb:0/0/f
set color4 = rgb:0/f/0
```

3.2 Plots

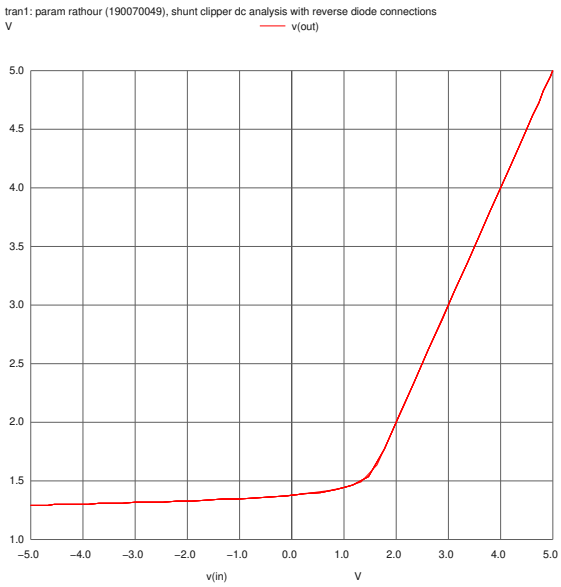
Note. *The voltage is given in Volts if not specified.*

3.2.1 Shunt Clipper Transient analysis with reverse diode connections

As shown in the Figure 4, we get a clipping effect where output voltage $\sim 1.3V$.
The effect is also clearly visible in the output vs input voltage relationship (change in slope).



(a) V_{out}, V_{in} vs time

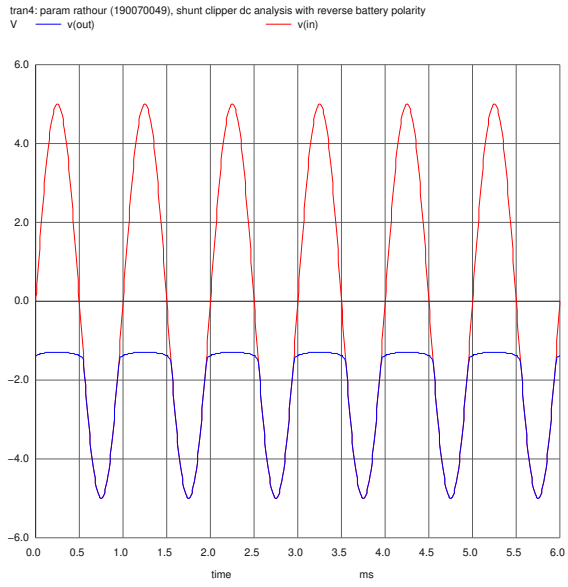


(b) V_{out} vs V_{in}

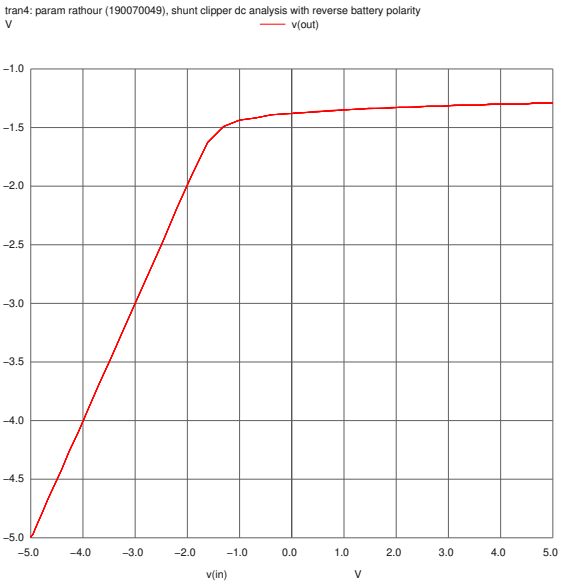
Figure 4: Shunt Clipper (Diode Reversed)

3.2.2 Shunt Clipper Transient analysis with reverse battery polarity

As shown in the Figure 5, we get a clipping effect where output voltage $\sim -1.3V$.
The effect is also clearly visible in the output vs input voltage relationship (change in slope).
The output voltage is clipped in reverse direction (negative not positive like Figure 4.)



(a) V_{out}, V_{in} vs time

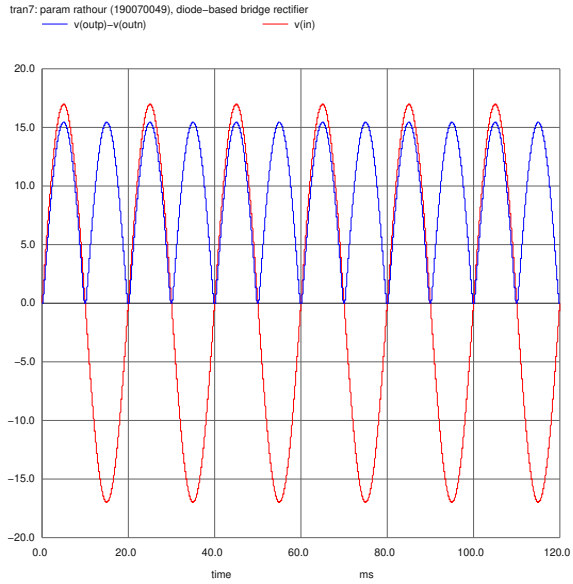


(b) V_{out} vs V_{in}

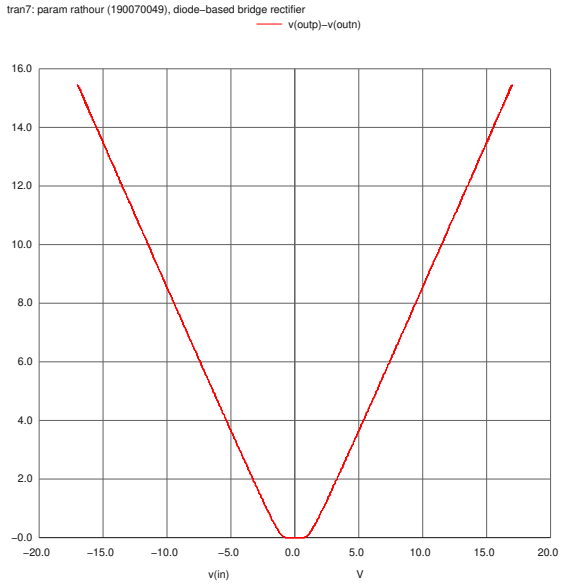
Figure 5: Shunt Clipper (Battery Polarity Reversed)

3.2.3 Diode-Based Bridge Rectifier

We get the DC (only positive) output for sinusoidal input as expected. (Fig 6)
The almost V shape output for V_{out} vs V_{in} is also as predicted.
Here the peak output voltage is a little less due to diode's threshold voltages.



(a) V_{out}, V_{in} vs time



(b) V_{out} vs V_{in}

Figure 6: Diode-Based Bridge Rectifier

4 Experiment completion status

I was able to complete all sections in lab.
In attempt to dash though these simple programs, I made a few silly mistakes. Thankfully, I realised them before lab completion and *rectified* my submission :p.

5 Questions for reflection

Overall, the lab was good. Although reports took the most of time as the experiments itself were elmentary. Looking forward to future labs.
Thanks!