EE 320 L ELECTRONICS I

LABORATORY 5: CLIPPERS, CLAMPERS AND VOLTAGE REGULATORS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
UNIVERSITY OF NEVADA, LAS VEGAS

1. OBJECTIVE

Apply diode knowledge to practical applications. Have a deeper understanding on how diodes affect the circuits and their frequency responses. Compare various approaches to regulate or limit the circuit outputs.

2. COMPONENTS & EQUIPMENT

Power Supply	Breadboard & Jump wires
Function Generator	Resistors & Capacitors
Multimeter	Diodes (1N4001, 1N4148, 1N4375)
Oscilloscope	Regulators (LM7805, LM7905)

3. BACKGROUND

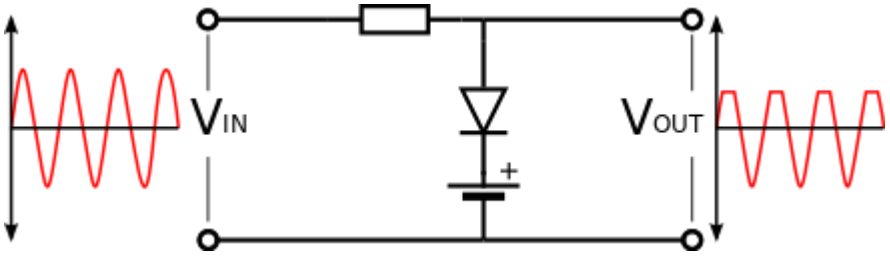
A clipper (i.e. clipping circuit) is a circuit designed to prevent the output of a circuit from exceeding a preset voltage level without distorting the remaining part of the applied waveform.

A clamper (i.e. clamping circuit) is a circuit that fixes either the positive or the negative peak excursion of a signal to a defined value by shifting its DC offset.

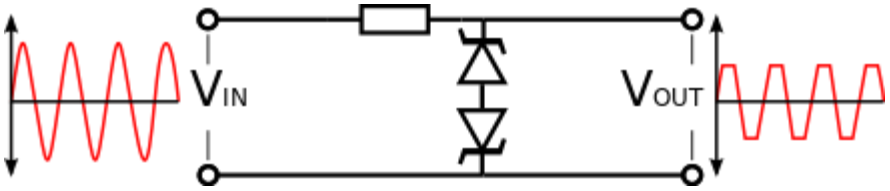
A voltage regulator is an electronic circuit that provides a stable DC voltage independent of the load current, temperature and AC line voltage variations. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Key knowledges and formulas related to clippers, clampers and voltage regulators.

Clipping Circuits:

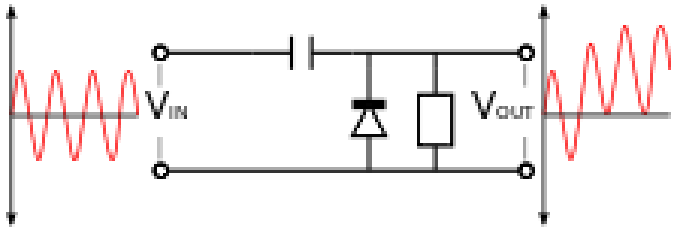


A positive peak clipper circuit.

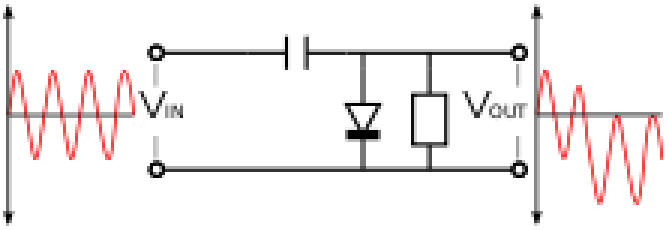


A two-shunt diode clipper circuit.

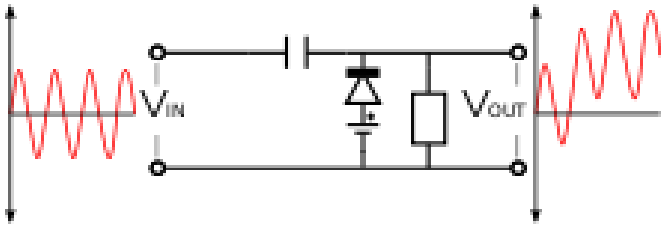
Clamping Circuits



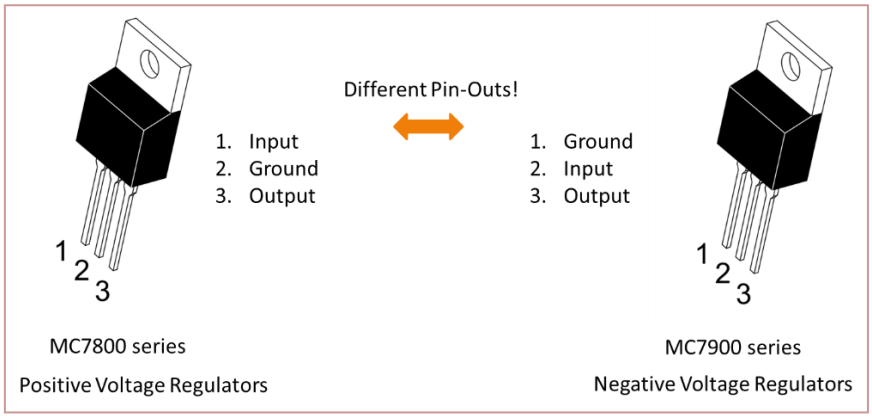
A positive unbiased clamp.



A negative unbiased clamp.



A positive biased clamp.

Voltage Regulators:	

4. LAB DELIVERIES

PRELAB:

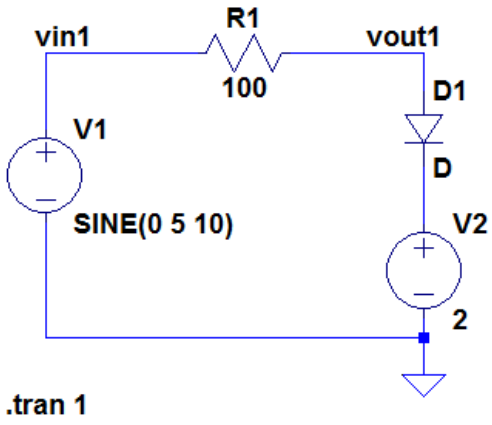
1. **Learn the idea of clippers, clampers and voltage regulators, part of which are listed in the previous section. Comprehend the principle of these circuits.**
   - You can review voltage regulators in http://eelabs.faculty.unlv.edu//docs/labs/ee221L/ee221L_07_experiment_7.pdf

2. **Overview the key character of diodes in their datasheets.**

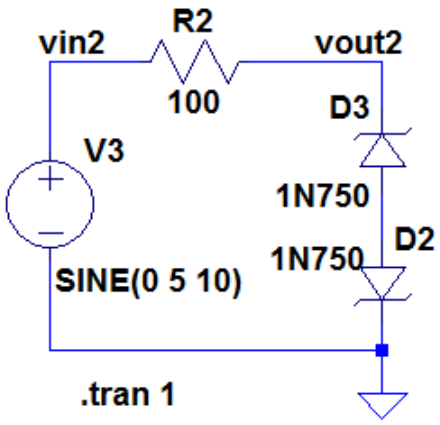
LM7805	https://www.sparkfun.com/datasheets/Components/LM7805.pdf
LM7905	http://www.ti.com/lit/ds/symlink/lm79.pdf

3. **Use LTspice to simulate Circuit 1.**
   1) Observe the voltage at "vin1" and "vout1". Write down the peak voltage (V_p) and peak-to-peak voltage (V_{pp}) of "vout1".
   2) Increase the DC voltage (V2) from 2V to 3V. Observe the output changes.
   3) Run the ac analysis for the Bode plot of the AC input from 10Hz to 1MHz.

4. **Use LTspice to simulate Circuit 2.**
   1) Observe the voltage at "vin2" and "vout2". Write down the peak voltage (V_p) and peak-to-peak voltage (V_{pp}) of "vout2".
   2) Increase the amplitude of AC input from 5V to 10V. Observe the output changes.
   3) Run the ac analysis for the Bode plot of the AC input from 10Hz to 1MHz.



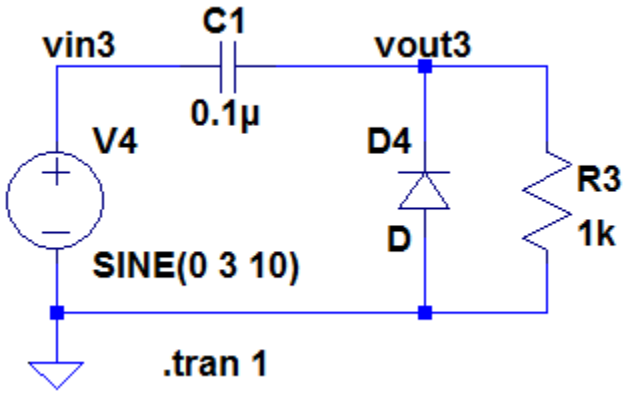
Circuit 1.



Circuit 2

5. Use LTspice to simulate Circuit 3.

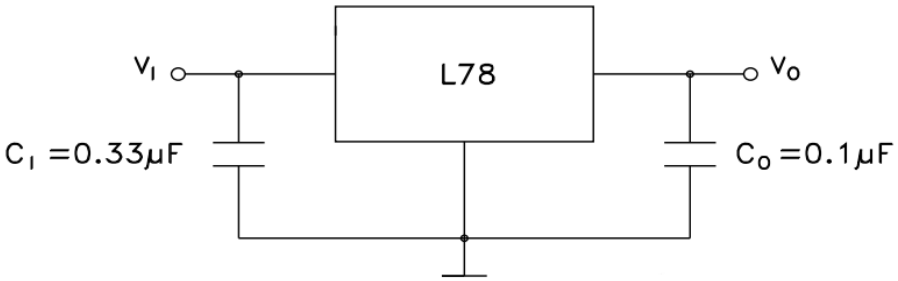
1) Observe the voltage at "vin3" and "vout3". Write down the peak voltage (V_p) and peak-to-peak voltage (V_{pp}) of "vout3".
2) Change the capacitor to 100 μF. Observe the changes at output.
3) Stay with 100 μF, change the input frequency, and run the ac analysis for Bode plot from 10Hz to 1MHz. What can you conclude?



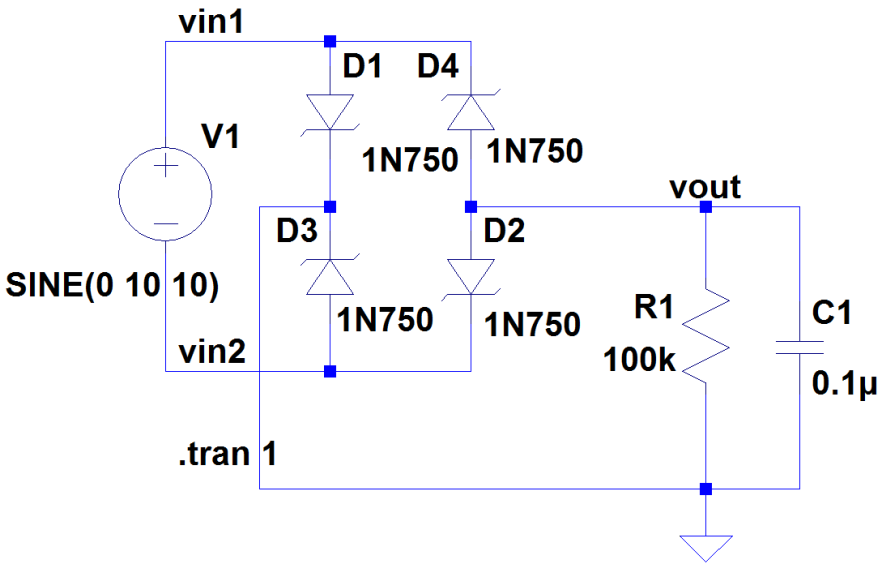
Circuit 3

6. Use LTspice to simulate and compare the output of voltage regulator (Circuit 4) and full-wave rectifier (Circuit 5).

1) Apply a sine wave input of V_{pp} = 10V, V_{offset} =0V, f = 10Hz for "V_I "(Circuit 4) and "vin1" (Circuit 5). Use "LT1083-5" for L78 in LTspice. Observe the outputs, V_p and V_{pp}, of Circuit 4 and Circuit 5, respectively.
2) Run AC analysis for Circuit 4 from 10Hz to 1MHz, and draw the Bode plots.
3) What if replace C_I and C_o with R_I = R_o = 10KΩ? Repeat 2), observe and explain the changes.
4) Run AC analysis for Circuit 5 from 10Hz to 1MHz, and draw the Bode plots.



Circuit 4



Circuit 5

LAB EXPERIMENTS:

1. **Implement and measure Circuit 1 in Prelab Experiment 3 on breadboard, and compare the hand-calculation and LTspice results.**
   - Use 1N4001 for regular diodes.

2. **Implement and measure Circuit 2 in Prelab Experiment 4 on breadboard, and compare the hand-calculation and LTspice results.**
   - Use 1N4375 (not 1N750 in Prelab diagram) for Zener diodes.

3. **Implement and measure Circuit 3 in Prelab Experiment 5 on breadboard, and compare the hand-calculation and LTspice results.**

4. **Implement and measure Circuit 4 & 5 in Prelab Experiment 6 on breadboard, and compare the hand-calculation and LTspice results.**
   - Use LM7805 (or similar) for voltage regulator.

POSTLAB REPORT:

Include the following elements in the report document:

<table>
<tr><th>Section</th><th colspan="2">Element</th></tr>
<tr><td>1</td><td colspan="2">Theory of operation
Include a brief description of every element and phenomenon that appear during the experiments.</td></tr>
<tr><td>2</td><td colspan="2">Prelab report
1. Hand calculation results of Prelab Experiment 3~6.
2. LTspice schematics and simulation results of Prelab Experiment 3~6.</td></tr>
<tr><td rowspan="6">3</td><td colspan="2">Results of the experiments</td></tr>
<tr><td>Experiments</td><td>Experiment Results</td></tr>
<tr><td>1</td><td>Screenshots of LTspice simulations and oscilloscope waveforms, and V_p, V_{pp} values.</td></tr>
<tr><td>2</td><td>Screenshots of LTspice simulations and oscilloscope waveforms, and V_p, V_{pp} values.</td></tr>
<tr><td>3</td><td>Screenshots of LTspice simulations and oscilloscope waveforms, and V_p, V_{pp} values.</td></tr>
<tr><td>4</td><td>Screenshots of LTspice simulations and oscilloscope waveforms, and V_p, V_{pp} values.</td></tr>
<tr><td rowspan="5">4</td><td colspan="2">Answer the questions</td></tr>
<tr><td>Questions</td><td>Questions</td></tr>
<tr><td>1</td><td>Pls explain the changes in Circuit 2 Step 2).</td></tr>
<tr><td>2</td><td>Pls explain what do you observe regarding the voltage reading at DC power supply when you use 100Ω resistor in Circuit 2 (i.e. why voltage cannot go lower than 2.4V)? What if you use a 10KΩ resistor?</td></tr>
<tr><td>3</td><td>Pls explain the changes in Circuit 3 Step 2) ~ 3).</td></tr>
<tr><td>4</td><td>What can you conclude after comparing the outputs of Circuit 4 and 5, and their Bode plots?</td></tr>
</table>

5	**Conclusions** *Write down your conclusions, things learned, problems encountered during the lab and how they were solved, etc.*
6	**Images** *Paste images (e.g. scratches, drafts, screenshots, photos, etc.) in Postlab report document (only .docx, .doc or .pdf format is accepted). If the sizes of images are too large, convert them to jpg/jpeg format first, and then paste them in the document.* **Attachments (If needed)** *Zip your projects. Send through WebCampus as attachments, or provide link to the zip file on Google Drive / Dropbox, etc.*

5. REFERENCES & ACKNOWLEDGEMENT

1. Adel S. Sedra & Kenneth C. Smith, "Microelectronic Circuit", 6th Ed.
2. Online sources:

   Google, Wikipedia, etc.

   https://www.quora.com/What-is-the-difference-between-clipping-and-clamping-circuits
3. Previous lab instructions.
4. Related circuit component datasheets.

I appreciate the help from faculty members and TAs during the composing of this instruction manual. I would also thank students who provide valuable feedback so that we can offer better higher education to the students.