RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science

Department of Electrical and Computer Engineering

Course Number	ELE504
Course Title	Electronic Circuits II
Semester/Year	Fall 2021

Instructor	Dr. Mike Kassam

ASSIGNMENT No.	**5**

Assignment Title	Linear Voltage-Controlled Function Generator (Milestone 2)

Submission Date	October 15, 2021
Due Date	October 15, 2021

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1. Introduction

The report for Milestone 2 of the ELE504 major project, is presented herein. The lab session for this experiment took place on October 15th, 2021.

2. Objectives

The objective of this lab was to design, implement and test two separate components, where it is deemed optional to assemble them together for testing. The Fixed Frequency Waveform Generator is slightly re-designed from Milestone 1 to accommodate for the usage of a limiter circuit with Zener diodes, and the DC-to-$\pm$DC converter is designed with respect to the recommended approach from Figure 4.0 of the Major Project’s manual document. Through the necessary simulations, the results of the Prelab assignment and the experiment are compared thoroughly to take into account any discrepancies that may occur. For the DC-to-$\pm$DC converter, an input D.C. voltage is incremented by 1 volt each time it’s tested to verify the Prelab design.

3. Prelab Assignment Summary

For the Prelab assignment and the lab, the following data were provided by Mr. Perczak (section 4 TA) for calculations and experimentation, as presented in **Table 3.1**. The following data was used in the Prelab assignment (Parts a and b), and the experiment as well.

Table 3.1: Parameter set provided for the Major Project of the ELE504 course.

f_o = 3100 Hz

Through the Prelab assignment, the provided parameters and calculated parameters from Milestone 1 are taken into account when designing the two components for this project. The OP-AMPs now use power supplies of +/- 6 volts and from Milestone 1, the high and low threshold voltages are at approximately +/- 5.71 volts and a capacitor of 0.1 μF is used in the inverting integrator.

When re-designing the Fixed Frequency Function Generator, the inverting integrator is connected to the noninverting bistable multivibrator, with the addition of the limiting circuit before the output voltage. The limiting circuit contains two Zener diodes in opposite directions. For this section, a new value of the first resistor (with the integrator) is calculated, as well as the Zener voltage and resistance, assuming a constant voltage drop of 0.7 volts across the diodes that are part of the circuit design.

The DC-to-$\pm$DC converter is designed with respect to the recommendations from Figure 4.0 of the Major Project manual, which consists of a circuit with negative feedback connected to a MOSFET device that controls the value of the output voltage between 5 and -5 volts, as picked for the value of the D.C. voltage. The values of the six resistors are picked in the two cases where the MOSFET device is ON (-6 volts output voltage) and OFF (6 volts output voltage).

4. Experimental Results and Observations

All circuits from the lab manual are created and tested using the Multisim Software environment. The Fixed Frequency Function Generator is built and tested using one LM741CN and LM318N OP-AMP in saturation, and the 1N4734 Zener diode is used for the limiting circuit. **Figures 4.1-4.2** contain the simulation results for the first component, where the fixed frequency is compared between the Prelab and the experiment. Next, the DC-to-±DC converter is built and tested using the LM741CN OP-AMP and the function generator, which provides a signal of 6 volts peak at 3100 Hz frequency. **Figures 4.3-4.8** demonstrate the incremented voltage tests for the converter, starting from 1 volt to 6 volts peak at 3100 Hz frequency.

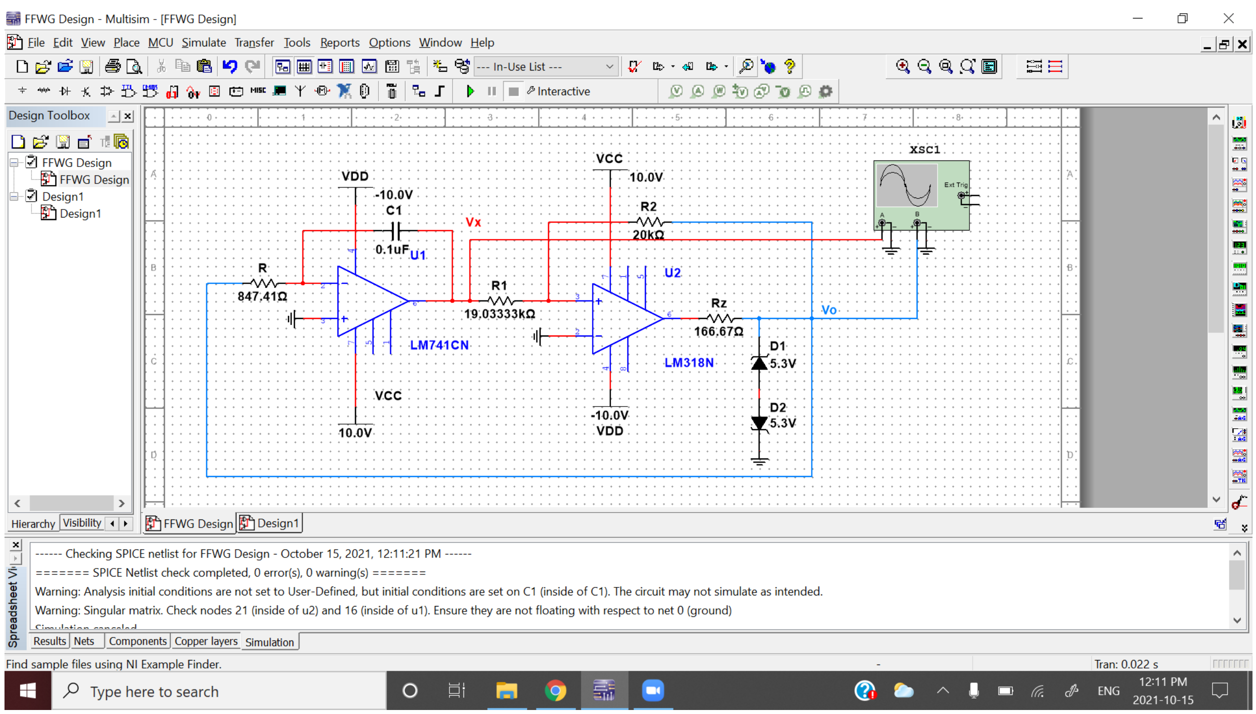

Figure 4.1: Multisim schematic of FFWG with one LM741CN and one LM318N OP-AMP - part 1.

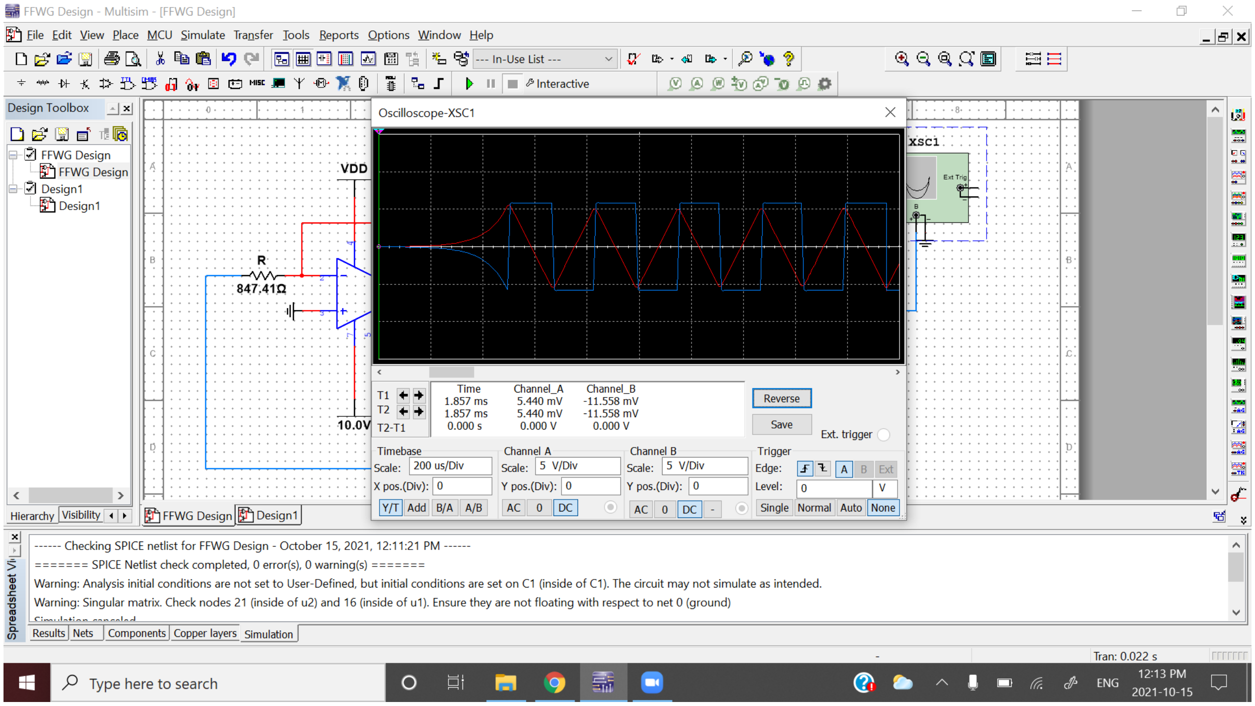

Figure 4.2: Multisim schematic of FFWG with one LM741CN and one LM318N OP-AMP - part 2.

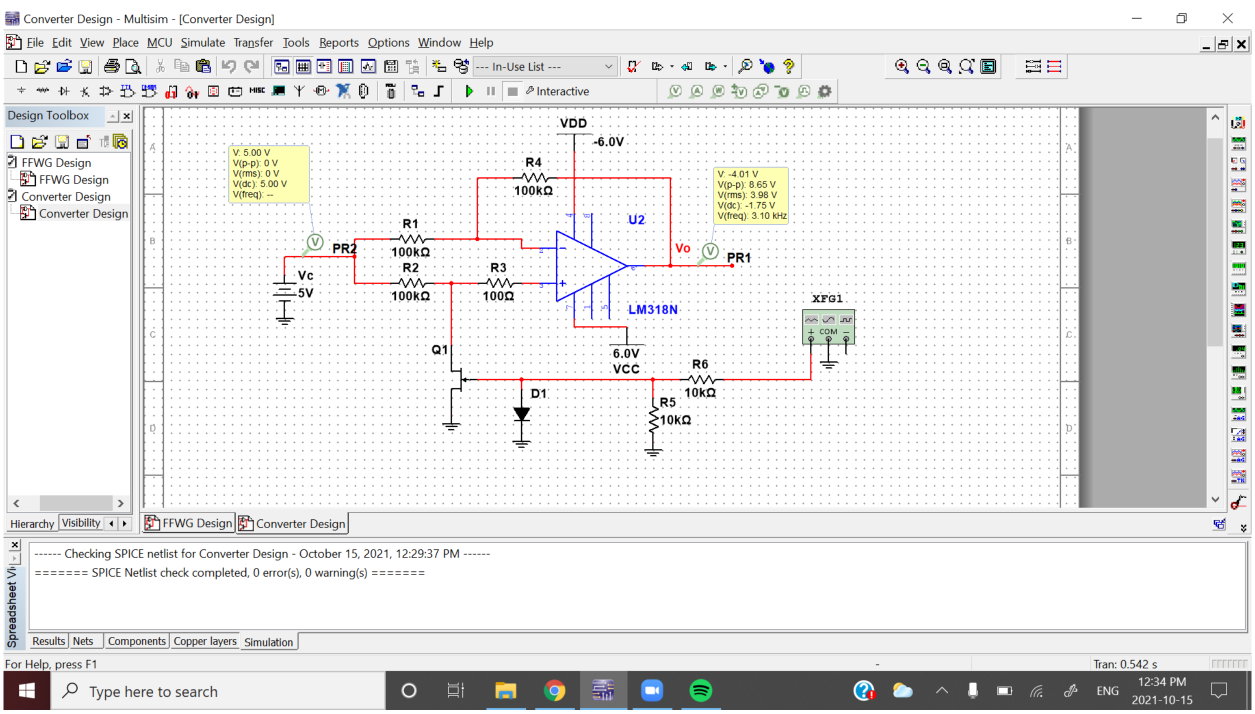

Figure 4.3: Multisim schematic of DC-to-DC converter - part 1.

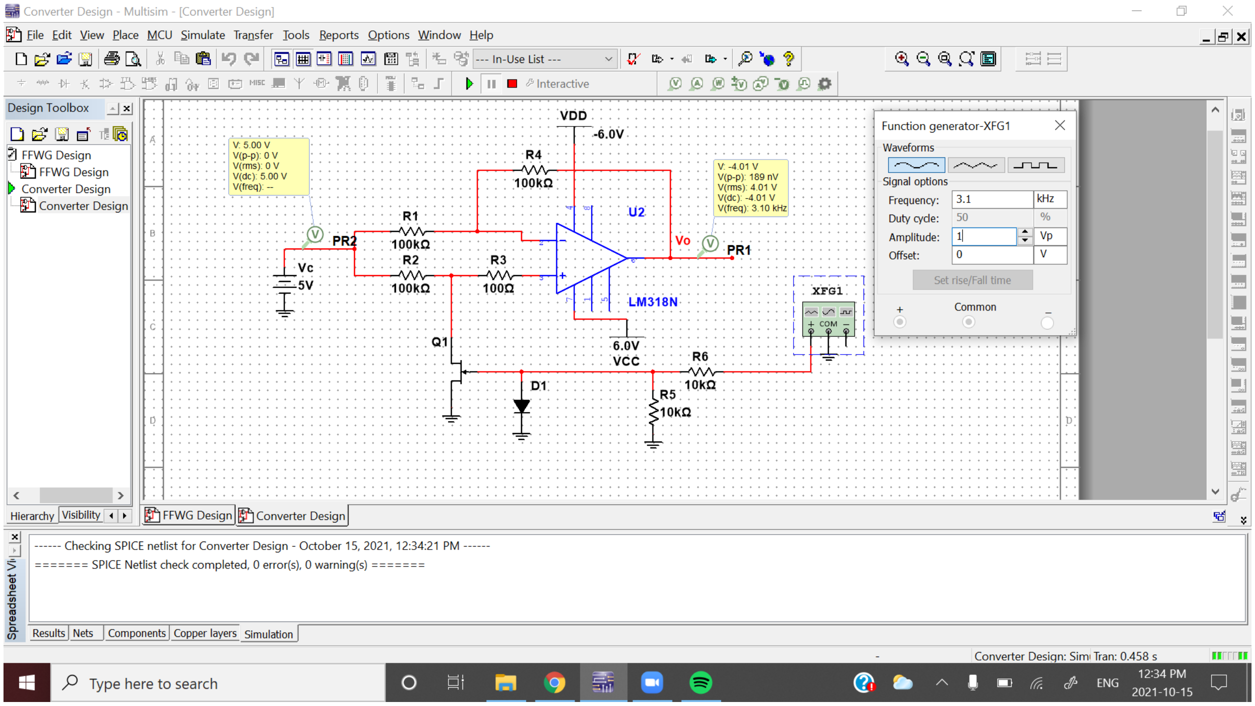

Figure 4.4: Multisim schematic of DC-to-DC converter - part 2 (testing at 1 Vp, 3100 Hz).

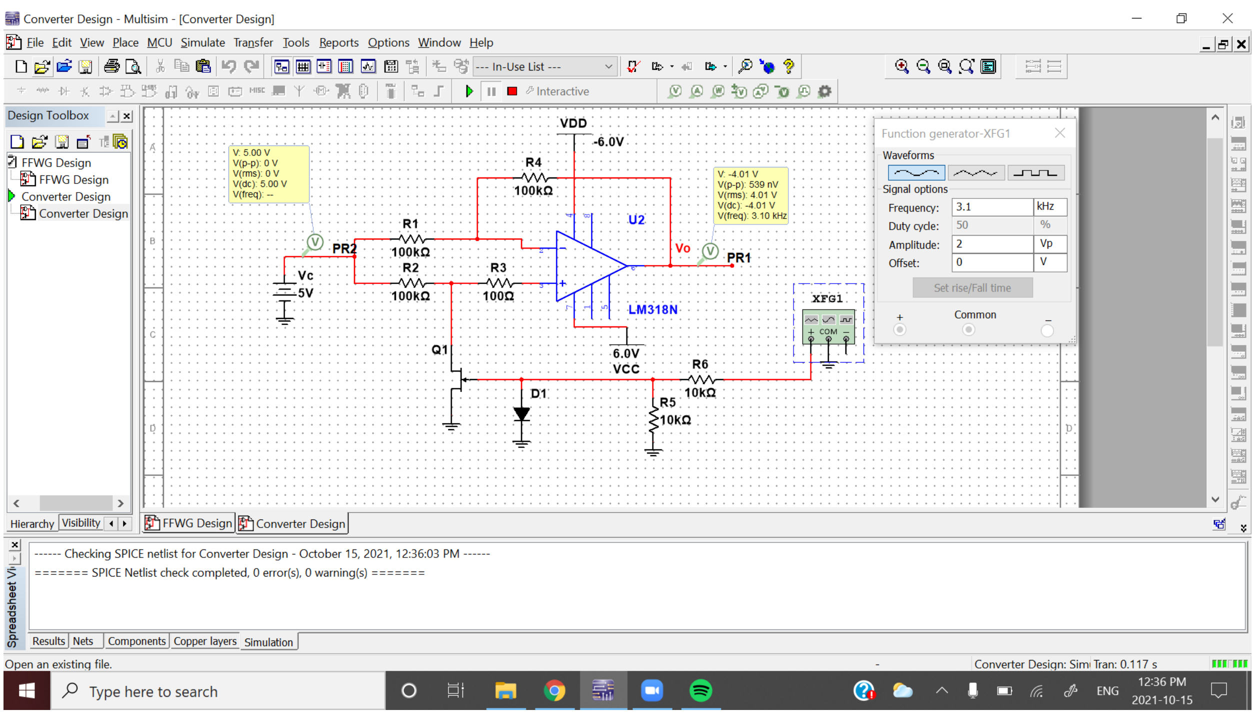

Figure 4.5: Multisim schematic of DC-to-DC converter - part 3 (testing at 2 Vp, 3100 Hz).

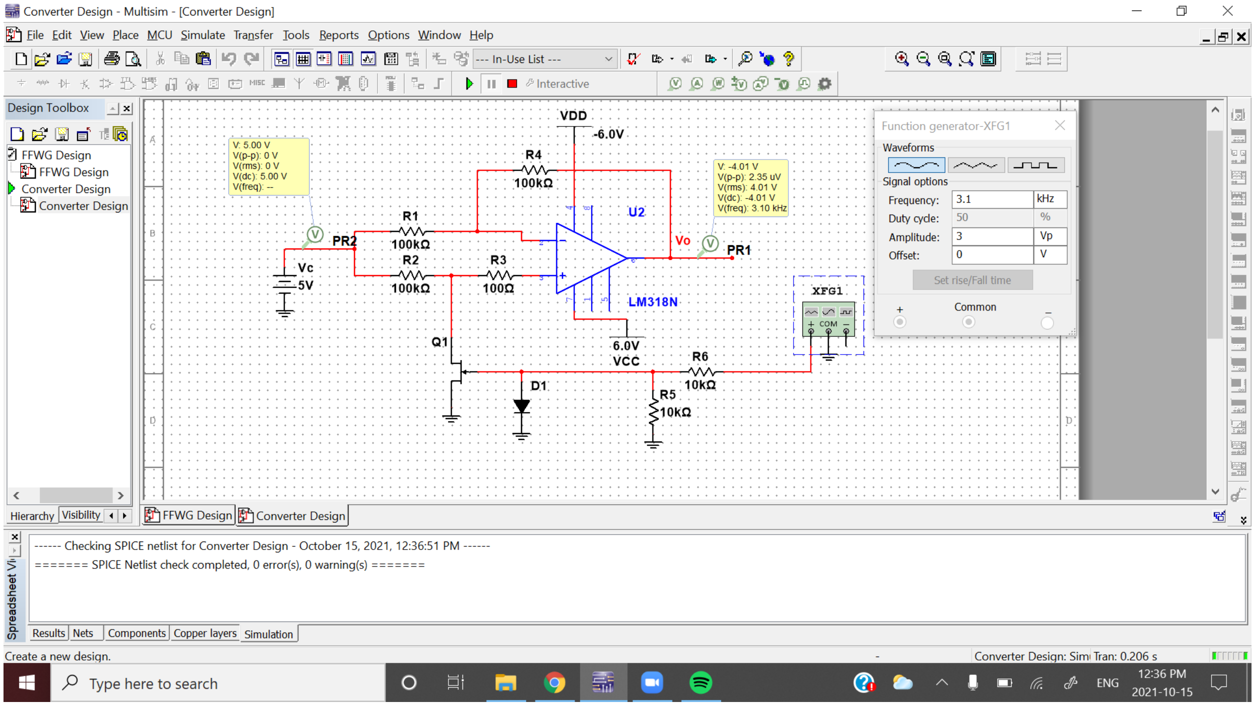

Figure 4.6: Multisim schematic of DC-to-DC converter - part 4 (testing at 3 Vp, 3100 Hz).

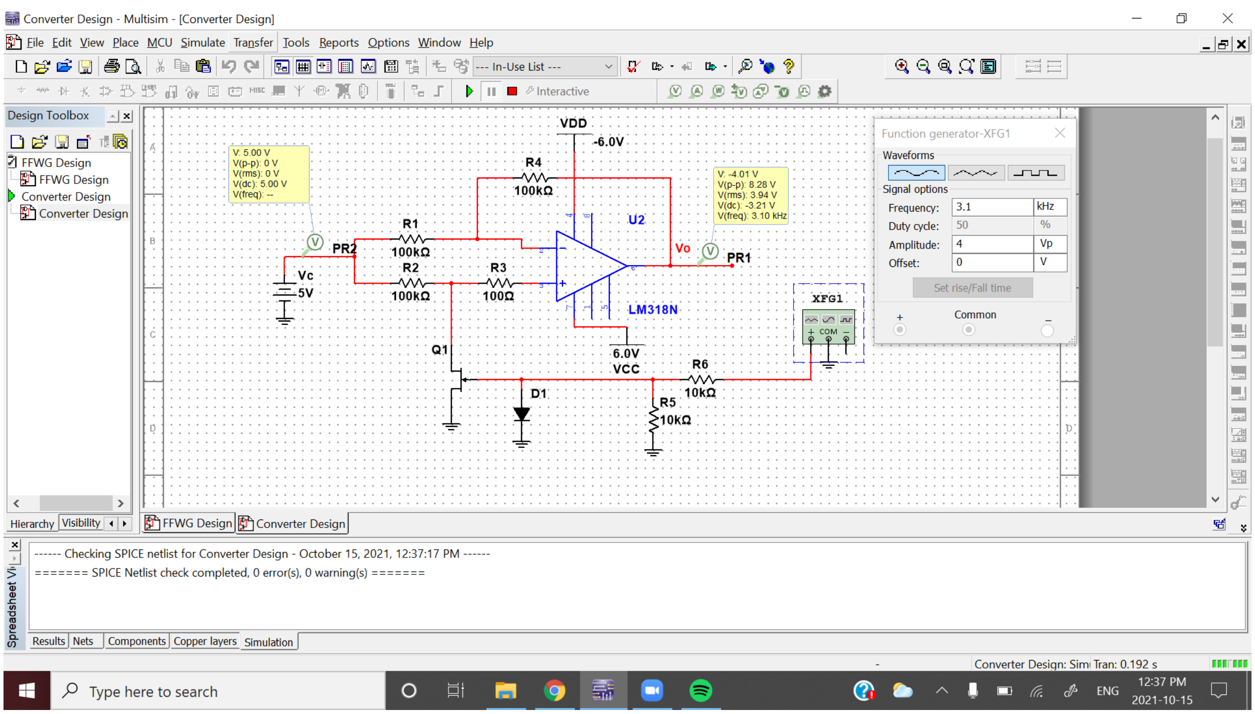

Figure 4.7: Multisim schematic of DC-to-DC converter - part 5 (testing at 4 Vp, 3100 Hz).

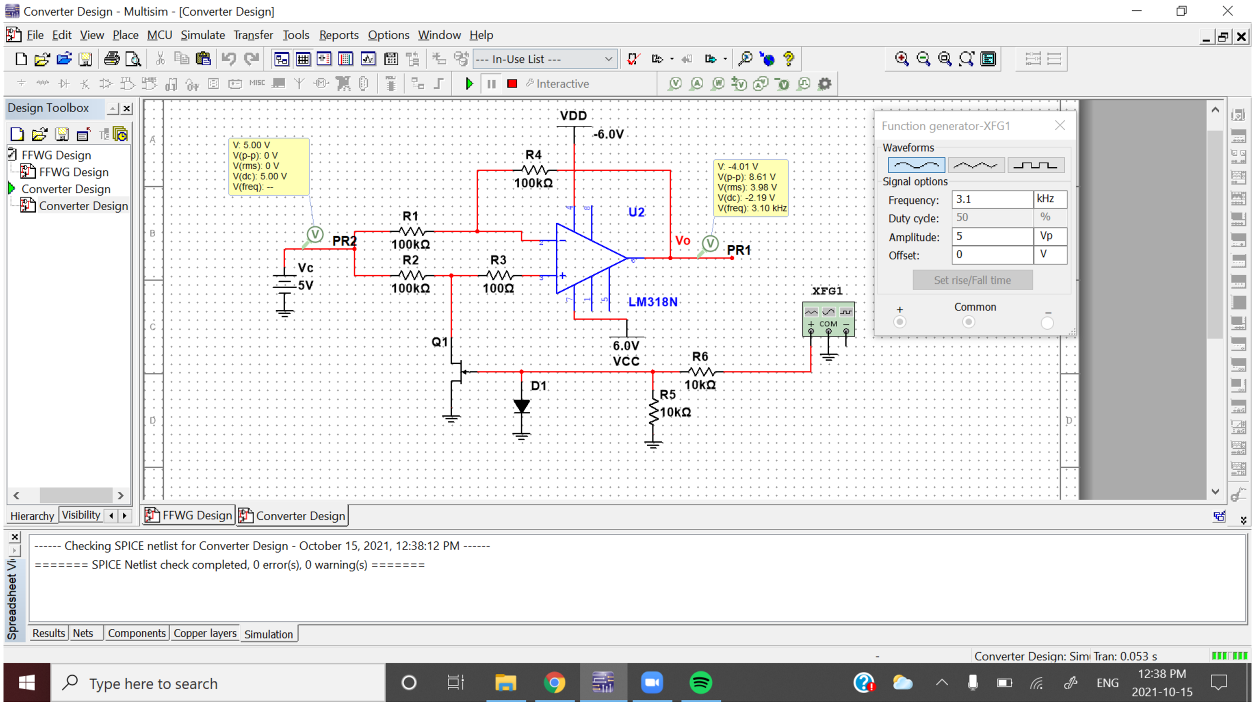

Figure 4.8: Multisim schematic of DC-to-DC converter - part 6 (testing at 5 Vp, 3100 Hz).

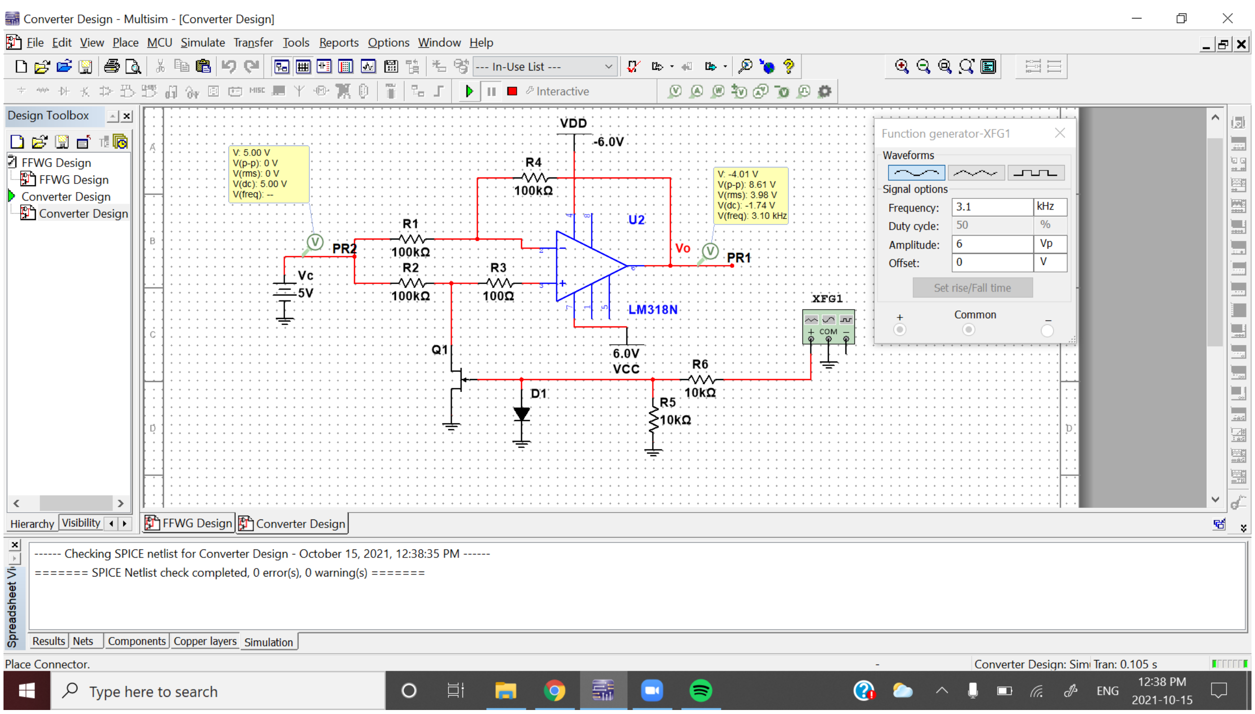

Figure 4.9: Multisim schematic of DC-to-DC converter - part 7 (testing at 6 Vp, 3100 Hz).

5. Conclusions and Remarks

When comparing the theoretical (Prelab assignment) and the experimental (Multisim) results of this experiment, the design analysis's conclusions have translated to the simulation results in a consistent manner. For the waveform generator, it is observed that the Zener diodes have done their job of providing a stable and consistent output waveform, in the form of a square wave. The amplitude of 6 volts is observed clearly and although the waveform is not perfectly linear (due to slew rate constraint), the results are still very close to the design analysis. As for the DC-to-$\pm$DC converter, it is observed that as the test voltage is incremented from 1 volts peak to 6 volts peak, the OP-AMP's output voltage approaches the +/-5 volts value, as desired from the design analysis. There is a slight discrepancy, however, as the output doesn't reach the 5 volts required, but it is concluded that the non-ideal nature of the circuit that causes this discrepancy. Therefore, through the validation process of this report, it has been decided that the final design for the waveform generator and DC-to-$\pm$DC converter are consistent with the design analysis from the Prelab assignment.