PreLab 2: AC-to-DC Power Supply

• INTRODUCTION

An AC-to-DC power supply has several key components: the transformer, rectifier, filter capacitor, and voltage regulator. In lab, we will use a “28 VCT” transformer, which means the secondary voltage is 28 V_{RMS}. The “CT” means a center tap connection is available.

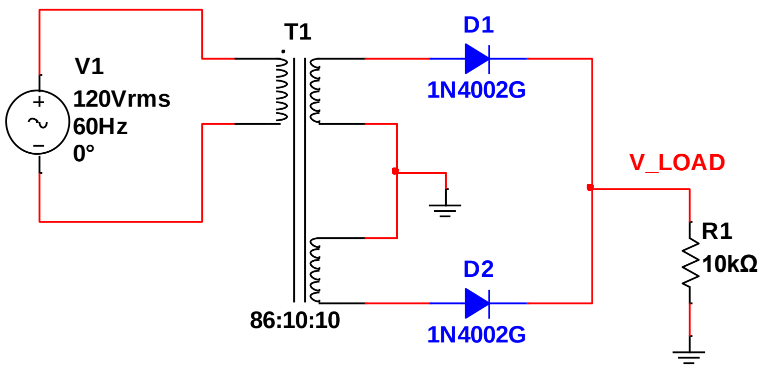

Fig. 1: Schematic of full-wave rectifier.

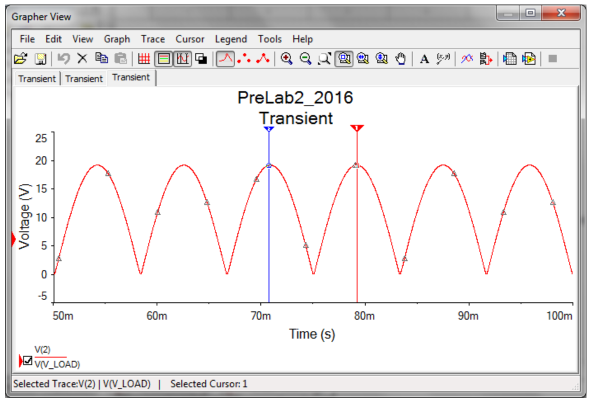

Fig. 2: Plot of the rectified waveform.

- **TASK 1**: Use Multisim to draw the circuit shown in Fig. 1.
  - The wall plug voltage is just an AC power source (**Sources** >> **Power_Sources** >> **AC_Power**).
  - The transformer can be found in **Basic** >> **Transformer** >> **1P2S**.
    - Multisim does not have an easy-to-use transformer with center tap. Instead, we will use a transformer with one primary and two secondary coils, as shown in Fig. 1.
    - Double-click on the transformer and configure the “number of turns” for each coil:
      - ➢ Use “Primary = 86”, “Secondary 1 = 10” and “Secondary 2 = 10”.
      - ➢ This means the voltage across each secondary coil is 8.6 times lower than the primary input.
      - ➢ Since there are two secondary coils, the “total” transformer ratio is actually 4.3:1. This is consistent with the 28VCT transformer used in lab, since $120V_{RMS}/4.3 \approx 28V_{RMS}$.
  - Label the wire above the 10 kohm load resistor as “V_LOAD”.
  - We’ll do a “transient” simulation (**Simulate** >> **Analyses and Simulation** >> **Transient**).
    - Use TSTART = 0.05s, TSTOP = 0.1s, and TMAX = 1e-5s.
    - NOTE: The simulation actually goes from 0 to 100 ms, but it only displays from t = 50 ms to 100 ms.
    - Run the simulation and use the “cursors” to measure the peak voltage (should be near 19V).
  - Calculate (e.g. by hand) the expected peak voltage from the full-wave rectifier. Assume the transformer ratio is 4.3:1 and that D1 and D2 have V_F = 0.7V (2nd approximation). **Show all work!**

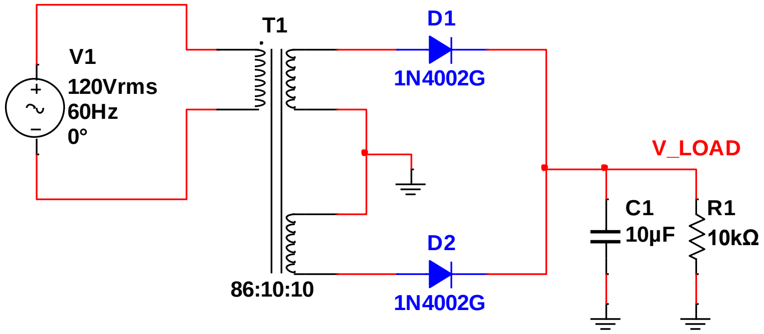

Fig. 3: Circuit with the 10uF filter capacitor.

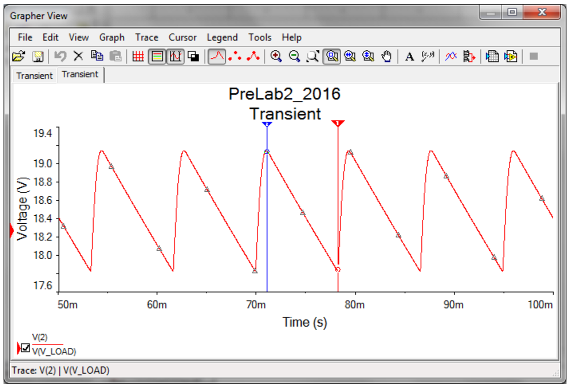

Fig. 4: Waveform showing ripple voltage.

- **TASK 2**: Now add a 10 uF filter capacitor, as shown in Fig. 3.
    - Perform a total of THREE simulations with the values of C1 and R1 shown in the table below. Use the cursors to measure V_peak and V_ripple in the simulated waveforms. Also calculate the theoretically expected values (e.g. using formulas). Write down the results in a table similar to the one shown below.

C1	R1	V_peak (sim)	V_peak (theory)	V_ripple (sim)	V_ripple (theory)
10uF	10 kohm				
10uF	1 kohm				
100 uF	1 kohm				

- **TASK 3**: OK, now it is time to analyze our results to see if they make any sense! Answer the following:
    - When C1 = 10 uF, explain why the ripple voltage is larger for R1 = 1 kohm compared to 10 kohm.
    - When R1 = 1 kohm, explain why increasing C1 leads to a smaller ripple voltage.
    - You should find significant disagreement between the simulated and theoretical V_ripple for C1 = 10 uF and R1 = 1 kohm. Explain why the theoretical result is so much larger than the simulation. Hint: Think about the linear approximation used to derive the ripple formula.
- **Make sure you submit the following:**
    - TASK1: Circuit schematic, waveform plot, measured and theoretical V_peak (show work).
    - TASK2: Circuit schematic (just one case, such as C1 = 10 uF, R1 = 10 kohm), ripple waveform for (C1 = 10uF, R1 = 10 kohm), completed table, and calculations for theoretical results (show work).
    - TASK 3: Answers to the questions.

(End of PreLab2)