University of Maryland Baltimore County
Department of Computer Science and Electrical Engineering

CMPE 314 Lab 2
Diode-Based Filtered Rectifier and Regulator Circuits

I. Objective

Examine filtered rectifier circuit. Theoretically and experimentally determine the proper resistance for the filter. Use Cadence Orcad PSPICE to simulate performance of a Zener-diode regulator circuit.

II. Equipment and Parts

Oscilloscope, DC power supply, function generator, digital multi-meter, breadboard, diodes, resistors, capacitors, 741 op amp and Cadence Orcad PSPICE (Cadence SPB -> Design Entry CIS).

III. Pre-Lab Exercise

Assume that the capacitance in Figure 1 is 22 μF and the frequency of the input sinusoidal signal is 60 Hz. . Use the definition of ripple voltage in class (also available in the textbook), calculate the proper load resistance R_{L_theory} such that the ripple of the filtered rectifier voltage is less than 10%.

III. Experiments and Procedures

Part (A). Diode-based filtered rectifier circuit

Filtered rectifiers convert AC waveforms into useful near-DC waveforms. Students should understand the factors affecting the output signal. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components. In this lab, we use Zener diode 1N4740. A voltage buffer amplifier is used to transfer a voltage from a first circuit, having a high output impedance level, to a second circuit with a low input impedance level. A unity gain buffer, also known as a voltage follower, has a voltage gain of approximately unity, while it provides considerable current gain and thus power gain.

In this experiment, a filtered rectifier will be measured. You will theoretically and experimentally determine the proper resistance for the filter. The experimental determination will be done using a variable resistor while observing ripping on an oscilloscope.

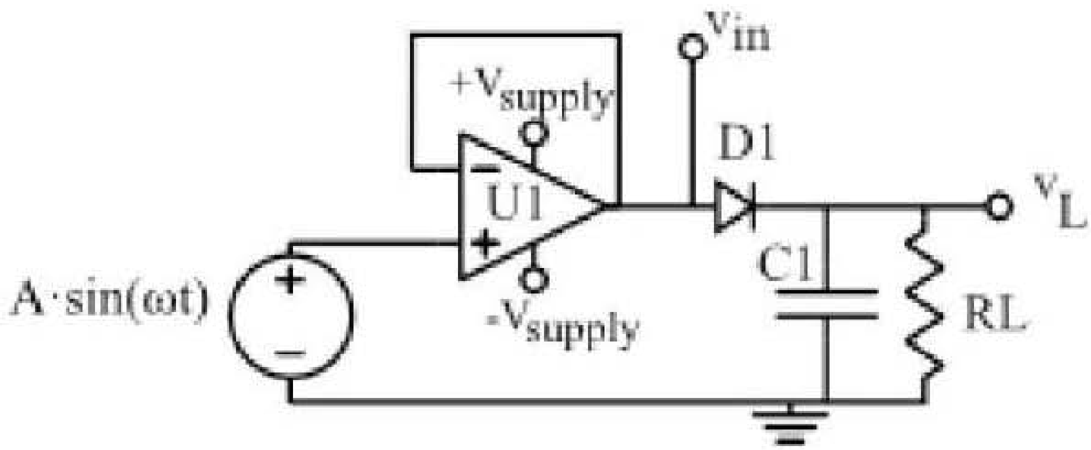

Figure 1: Filtered rectifier circuit. D1-Diode (1N4740); C1-Capacitor (22uF); RL-potentiometer (205: 20x105); U1-741 op amp

(1) Construct the circuit in Figure 1 using a 741 opamp to buffer the sinusoidal signal generator. The 741 opamp should be powered with +Vsupply= 10V and -Vsupply= -10V. The function generator connects to pin 3, the non-inverting input; while pin 6, the output, should connect to pin 2, the inverting input. Search online for 741 op amp datasheet if you are not sure how to connect.

(2) Connect two oscilloscope probes CH1 and CH2 respectively to Vin and VL and set the scope to measure the peak-to-peak value of VL.

(3) Set the input signal to be a 20 V peak-to-peak value, 60 Hz frequency waveform. (This means the amplitude should be set to 10 V on the function generator).

(4) On the oscilloscope, set the scales and offsets of CH1 and CH2 to be the same. The scales should be 5 ms/div and 1 V/div. Turn off averaging so you get quick updates.

(5) Vary the potentiometer until the output voltage ripple is less than 10%. Capture the input and output signals. Save the data so that you can further process the data if needed.

(6) Use multi-meter to measure the potentiometer resistance, which means the R_L resistance for the filter. Save your measurement as $R_{L\_Measured}$.

(7) Compare your expected value for R_L with the value of potentiometer you measured using multi-meter.

Part (B). Diode-based regulator circuit (simulation)

Perform the following simulation use Cadence Orcad PSPICE.

(1) Input a sinusoidal signal (frequency 600 Hz, peak-to-peak 20 V) to the diode-filtered rectifier circuit in Figure 1 (You may bypass the op-am in simulation). Simulate the output waveform. What is the ripple voltage?

(2) Generate an amplitude-modulation (modulation frequency 6 Hz, amplitude modulation 1 V) to the original sinusoidal signal. Input the amplitude-modulated sinusoidal signal to the diode-filtered rectifier circuit. Simulate the output waveform. What is the ripple voltage?

(3) Add an Zener diode (1N4732) in parallel to the capacitor in Figure 1.

(4) Repeat simulation for input signals in steps (1) and (2). What are the ripple voltages, respectively?

Report: Create theoretical output waveforms of the circuit (both input and output waveforms). Overlay the theoretical data and experimental data in same plot. Use different markers or colors to denote different waveforms, i.e. input, output, theoretical, experimental... Include legends, titles, labels for your plots. Points will be deducted if plots are not clear. Compare your theoretical and experimental data, and explain the discrepancy if there is any. Appropriate theory and equations will help you simplify your explanation and description.