LAB 4.2

Fun with Diodes I: Rectifiers

(See Section 4.5, p. 194 of Sedra/Smith)

OBJECTIVES:

To study diode-based rectifier circuits by:

- Analyzing, simulating, and building several rectifier circuits.
- Noting that many diode-based circuits are easy to assemble. In this lab, you will build several circuits that require only a few simple components.

MATERIALS:

- Laboratory setup, including breadboard
- Several junction diodes (e.g., 1N4003)
- One 741-type operational amplifier
- Several wires, resistors, and capacitors of varying sizes

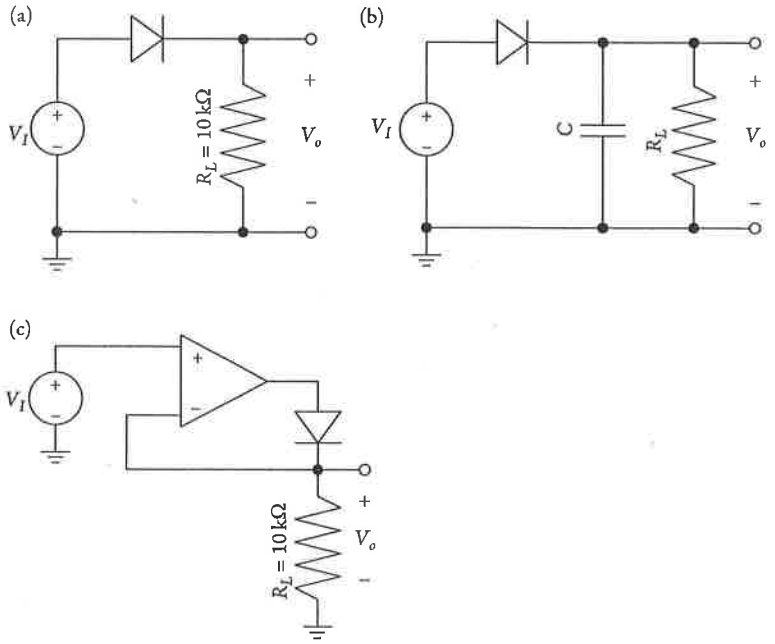

FIGURE L4.2: (a) Half-wave rectifier, (b) peak rectifier, and (c) precision rectifier. Circuits are based on Fig. 4.21 p. 196, Fig. 4.25 p. 202, and Fig. 4.27 p. 206 S&S.

PART 1: SIMULATION

Half-wave rectifier

Consider the half-wave rectifier shown in Figure L4.2(a). Simulate the circuit using a 10-V_{pk-pk} 1-kHz sinusoid and a 1N4003 diode. Provide a plot of v_I and v_0 vs. t.

Peak rectifier

Consider the peak detector shown in Figure L4.2(b). Simulate the circuit using a 10-V_{pk-pk} 1-kHz input sinusoid for the two following sets of parameters. For both simulations, provide a plot of v_I and v_O vs. t, and report the peak voltage (V_p) and the ripple voltage (V_r).

- Peak detector I: Use $R_L = 1\ \text{k}\Omega$, $C = 47\ \mu\text{F}$, 1N4003 diode
- Peak detector II: This time use $R_L = 100\ \Omega$, $C = 47\ \mu\text{F}$, 1N4003 diode

Precision rectifier

Consider the precision rectifier shown in Figure L4.2(c). Simulate the circuit using a 10-V_{pk-pk} 1-kHz sinusoidal input, a 741 op-amp, and a 1N4003 diode. Provide a plot of v_I and v_0 vs. t. Use $R_L = 10\ \text{k}\Omega$.

PART 2: MEASUREMENTS

- For each circuit, assemble the circuit, apply the required waveform using a function generator, and capture the input and output voltage waveforms on an oscilloscope.
- For the peak rectifier, record the values of V_p and V_r.
- Using a digital multimeter, measure all resistors to three significant digits.

PART 3: POST-MEASUREMENT EXERCISE

- Using your measured resistor values, resimulate your circuits. How do the updated results compare with your simulations, and experiments? Explain any discrepancies.
- What conclusions do you draw from the two different peak rectifiers?

PART 4 [OPTIONAL]: EXTRA EXPLORATION

Can you turn the precision half-wave rectifier into a precision peak rectifier?