Toronto Metropolitan University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Title:	Electronic circuits
Course Number:	404
Semester/Year (e.g.F2016)	W2025

Instructor:	Md Sadid Haque Waselul

Assignment/Lab Number:	3
Assignment/Lab Title:	Bridge rectifiers

Submission Date:	02-14-25
Due Date:	02-16-25

Student LAST Name	Student FIRST Name	Student Number	Section	Signature*
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*By signing above you attest that you have contributed to this written lab report and confirm that all work you have contributed to this lab report is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: https://www.torontomu.ca/content/dam/senate/policies/pol60.pdf

Introduction and Objective:

The purpose of this lab is to implement and analyze bridge rectifiers, which are wave-shaping circuit that allow the conversion of AC signals into DC signals by taking advantage of the one way current flow functionality of a diode. Bridge rectifiers are built and analyzed in this lab extensively along with their waveforms, where the usage of a smoothing capacitor in conjunction with the bridge rectifier is also looked at. The circuits built in this lab can be seen in the figures down below:

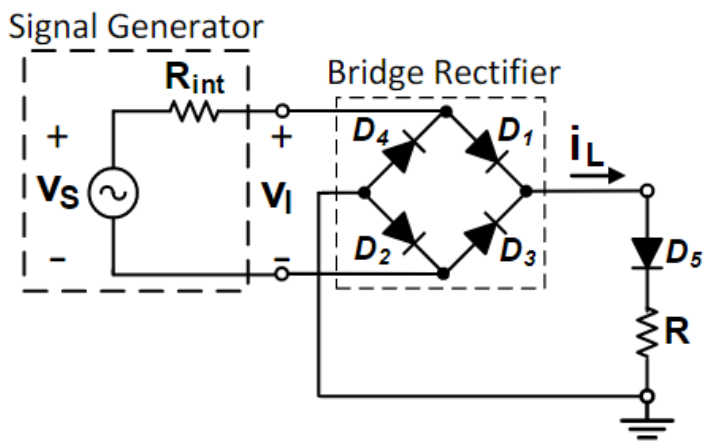


Figure 1.0 Bridge rectifier using LEDs.

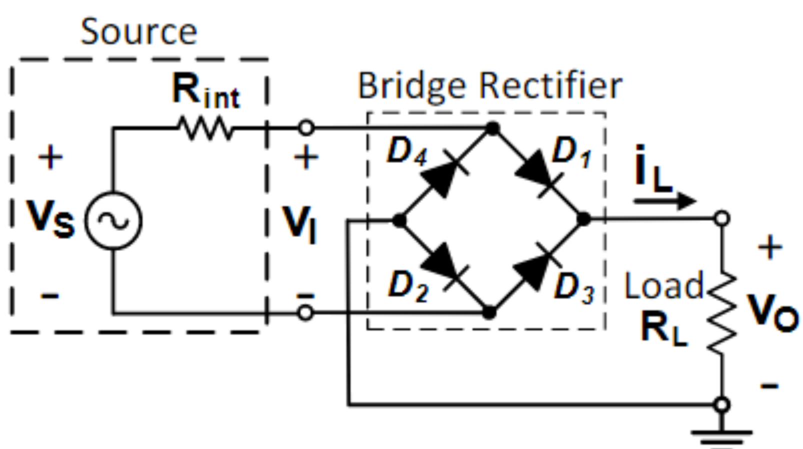


Figure 2.0 Bridge rectifier with a resistive load

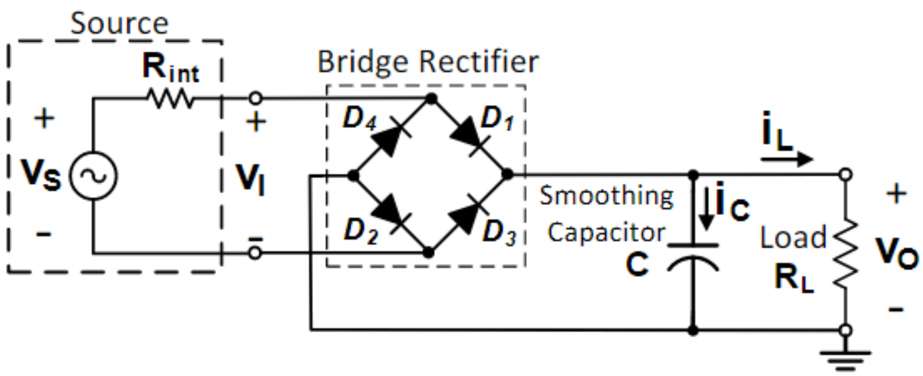


Figure 3.0 Bridge rectifier with smoothing capacitor.

Experiment and Results:

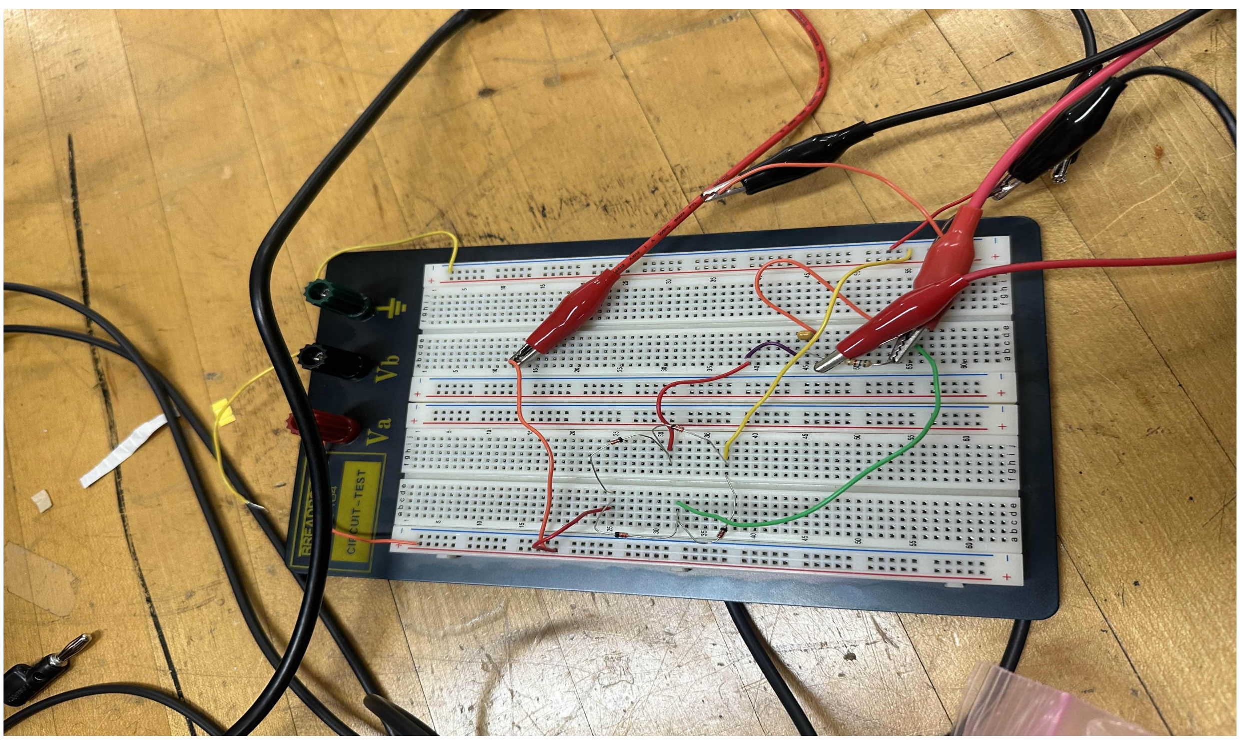
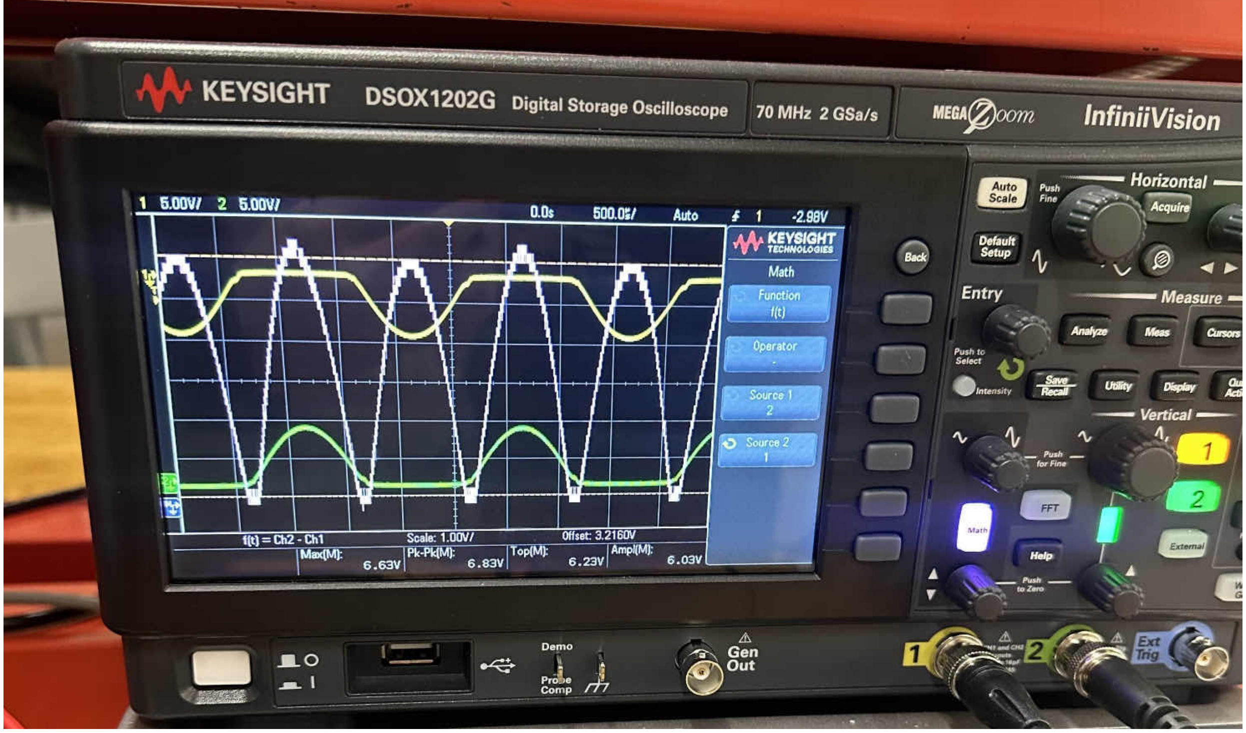
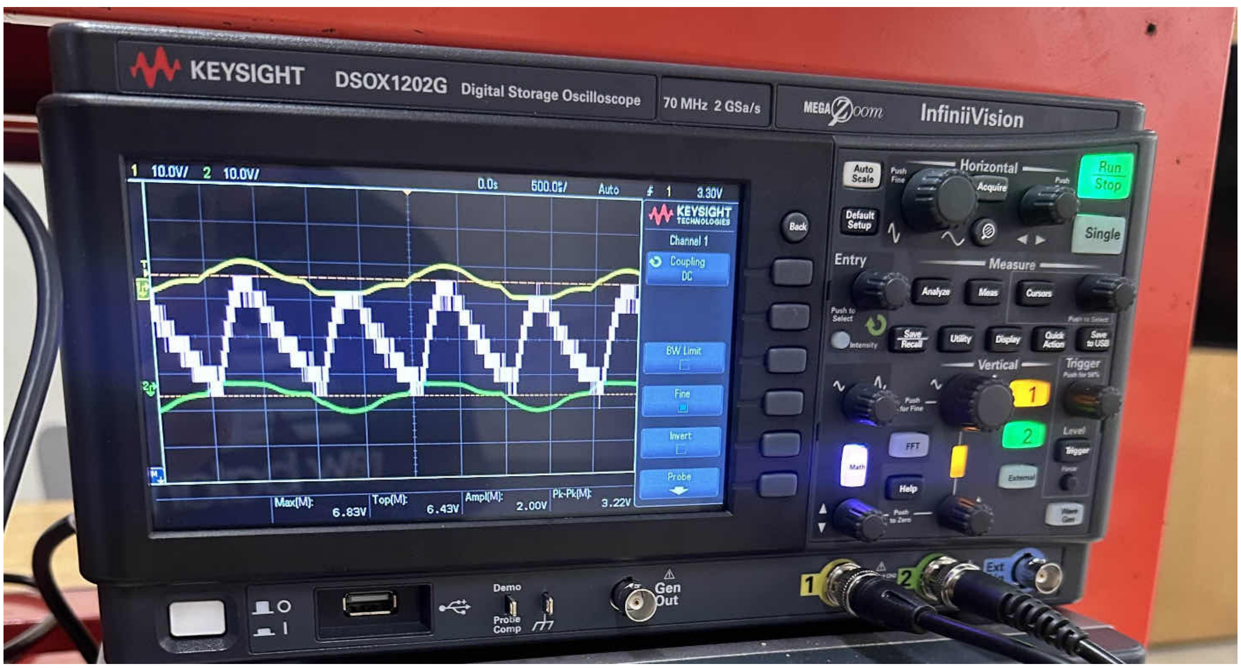


Figure 4.0: breadboard circuit of figure 3.0



Graph 1.0: Waveform for figure 2.0



Graph 2.0: waveform for figure 3.0

$\overline{v_O}$ [V]	V_r [V]
5.287V	3.62V

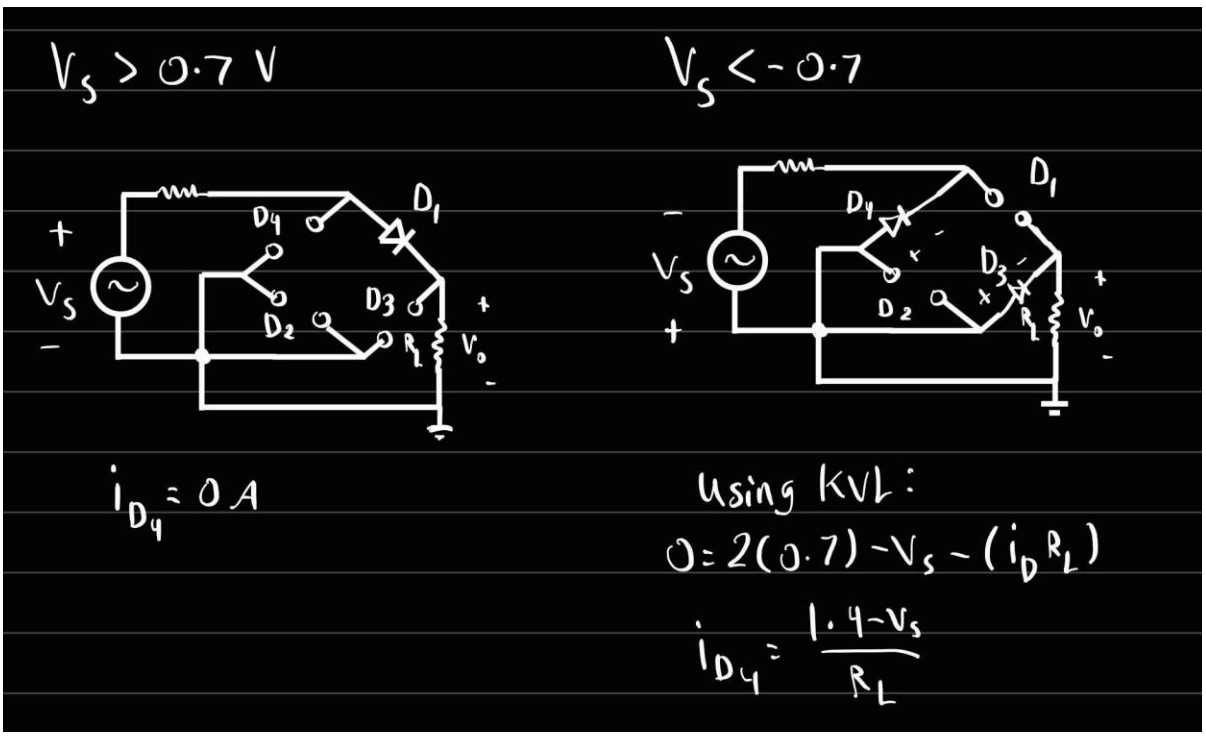
Table E3. DC output voltage and peak-to-peak ripple of the circuit in Figure 3.0

Conclusion and Remarks:

C1.

It can be seen that both sets of waveforms are similar and agree with the manually-derived transfer characteristic. A source of error may be the ideal voltage-drop model of the diode used in the manual derivation of the transfer characteristic, seen as the model is just an estimation of the property of the diode and not an exact method.

C2.



From the analysis and simulation of the circuit above, it can be seen that the usage of a shirt circuit to the negative terminal of the source causes the bridge rectifier to act as a half-wave rectifier, where current only flows through the load at voltages less than -0.7 volts.

C3.

Using Figure 4 as a reference, during positive half-cycles of v_S, the current flows through the red diode LEDs D_1 *and* D_2 since they are in series. It then flows through the green LED D_5 causing it to blink. Since this situation is the positive half cycle, red LEDs D_3 *and* D_4 are off since they are in reverse biased.

During negative half-cycles of v_s, the current flows through the red diode LEDs D_3 and D_4 since they are in series. It then flows through the green LED, D_5 causing it to blink. Since this situation is the negative half cycle, red LEDs D_1 and D_2 are off since they are in reverse biased.

C4.

Graph P2 (a) and Graph E2 look similar and do not have any discrepancies making the experimental graph acceptable.

C5.

Graph P4 (a) and Graph E3 have identical graphs, which in conclusion gives us no discrepancies making the experimental graph acceptable.

Measured DC Error Percentage: 28.12%

Ripple Voltage Error Percentage: 29.29%

The values of the measured DC and ripple voltage have a high percentage error when compared with our theoretical values. There are many discrepancies that were possible for error, including loose connections of the circuit, or even loose connections of the measuring devices such as the volt meter.

C6.

From the simulated waveforms, it can be seen that the higher the resistance of the load, the closer the waveform is to a perfect DC signal, where 56 ohms is still visibly a periodic signal, and 56k ohms is almost a straight non-periodic signal.

TA Copy of Results

Table E3. DC output voltage and peak-to-peak ripple

$\overline{v_O}$ [V]	V_r [V]
5.287	3.62V

	Partner's Name	Set-Up (out of 10)	Data Collection (out of 10)	Participation (out of 5)
1	Hamza Malik			
2	Ryan Taing			

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Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Title:	Electronic Circuits 1
Course Number:	ELE404
Semester/Year (e.g.F2016)	W2025

Instructor:	Md Waselul Haque Sadid

Assignment/Lab Number:	Pre-Lab #3
Assignment/Lab Title:	Bridge Rectifiers

Submission Date:	02-11-25
Due Date:	02-14-25

Student LAST Name	Student FIRST Name	Student Number	Section	Signature*
Taing	Ryan	501093407	11	Ryan

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Introduction

An important property of a diode is that it allows the current to flow in only one direction. This property is utilized for conversion of AC to DC in circuits that are known as *rectifiers*. This lab studies an important member of the family of rectifiers, that is, the so-called ***Bridge Rectifier***.

For manual calculations, assume the on-state voltage drop of a diode (e.g., 1N4148) to be 0.7 V.

Pre-lab Assignment

P1. For the bridge rectifier of **Figure 1**, derive the v_S-v_O transfer characteristic for a source voltage range of $-\mathbf{8}\ \boldsymbol{V} \leq \boldsymbol{v_S} \leq +\mathbf{8}\ \boldsymbol{V}$, assuming that the diodes are **1N4148** diodes and R_L is considerably larger than R_{int} (e.g., $R_L \geq 10R_{int}$). Present the characteristic curve as **Graph P1**.

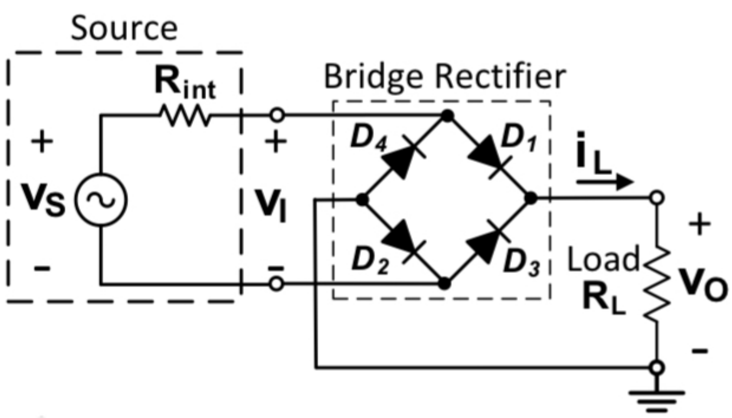
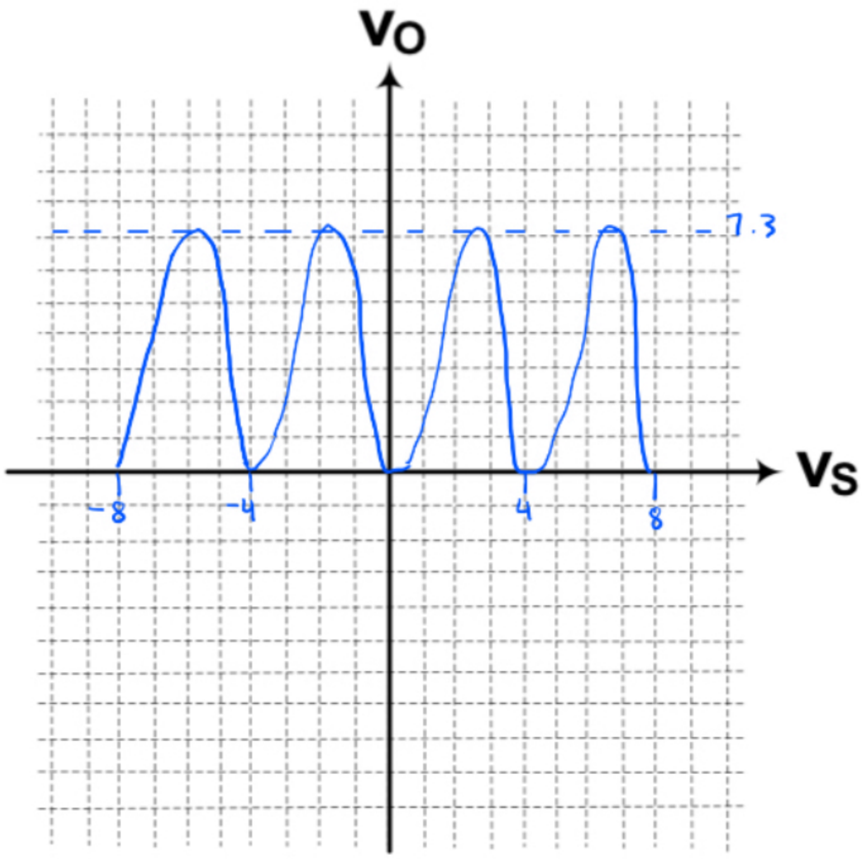
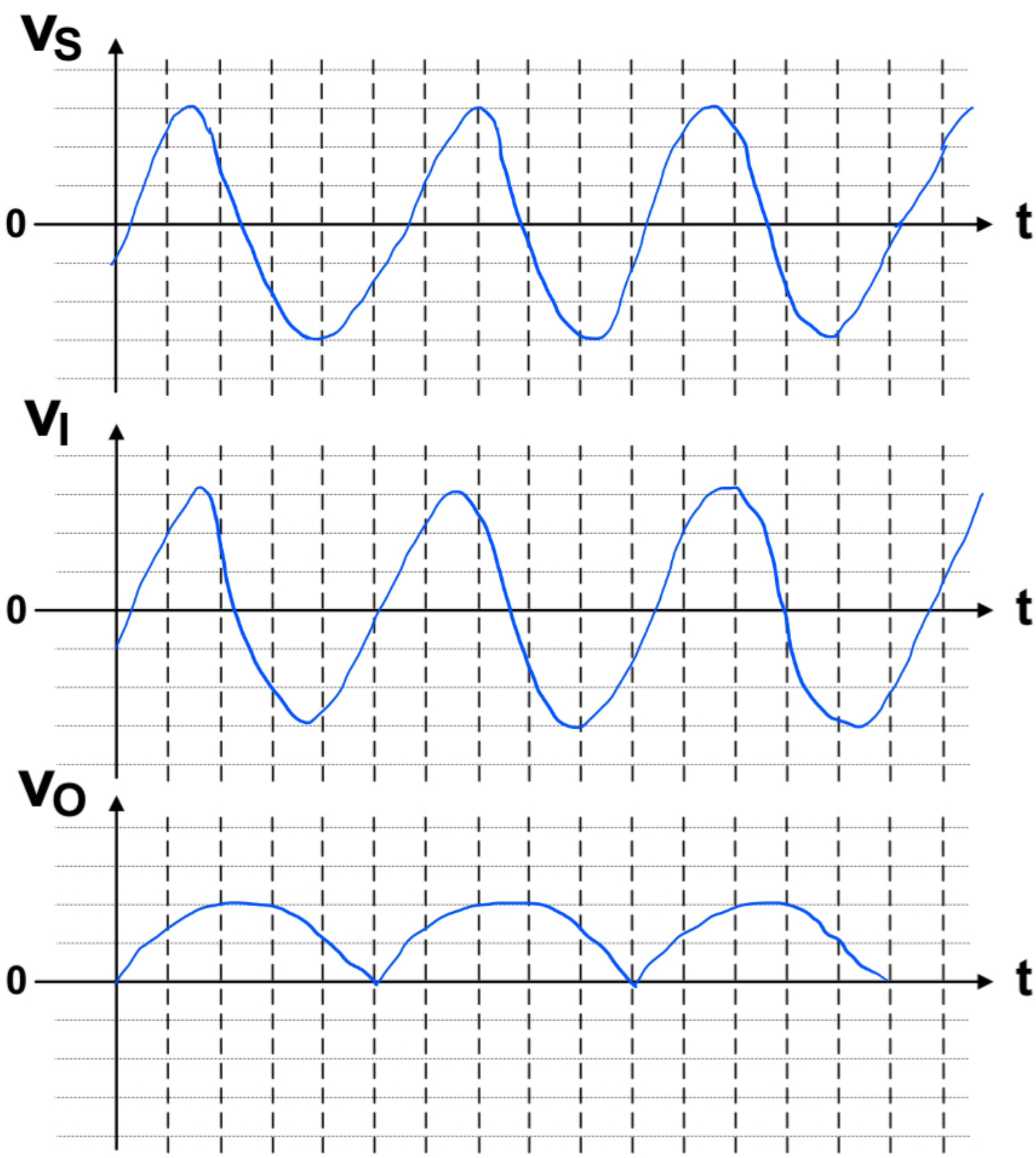


Figure 1. Bridge rectifier with a resistive load.

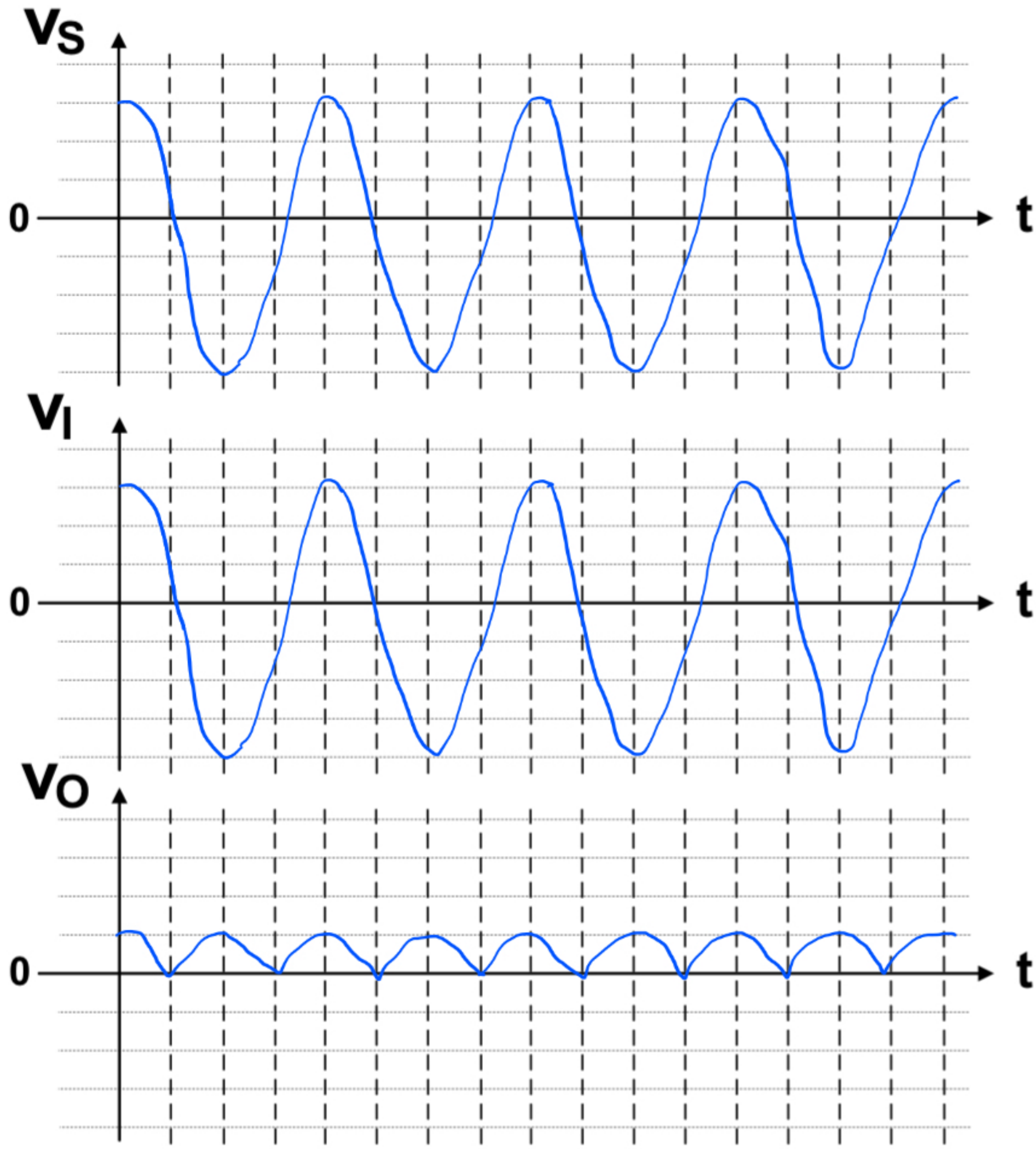


Graph P1. Transfer characteristic of the bridge rectifier of Figure 1.

P2. Assuming **1N4148** diodes, a **500-Hz symmetrical sinusoidal source voltage v_S with a magnitude of 16 V peak-to-peak**, and a source internal resistance of $\boldsymbol{R_{int}} = \mathbf{50\ \Omega}$, simulate the bridge rectifier of **Figure 1** with $\boldsymbol{R_L} = \mathbf{1\ k\Omega}$, and capture the waveforms of the source voltage v_S, input voltage v_I, and output voltage v_O, for about three cycles. Present the input and output voltage waveforms as **Graph P2(a)**. Repeat the simulation with $\boldsymbol{R_L} = \mathbf{270\ \Omega}$ and present the voltage waveforms as **Graph P2(b)**.



Graph P2(a). Source, input, and output voltage waveforms of the bridge rectifier of Figure 1, with 1N4148 diodes and $R_L = 1\ k\Omega$.



Graph P2(b). Source, input, and output voltage waveforms of the bridge rectifier of Figure 1, with 1N4148 diodes and $R_L = 270\ \Omega$.

P3. Consider the circuit of **Figure 2** and repeat the simulation of **Step P2** for it (with $R_L = 1\ k\Omega$, while the other parameters remain unchanged). Note that the circuit of **Figure 2** is the same circuit as that of **Figure 1,** but with a major difference: **The ground of the circuit (denoted by symbol ⏚) is shorted to the negative terminal of the source**. Capture the waveforms of v_I, v_O, and i_{D4}(i.e., the current of D_4) for about three cycles, as **Graph P3**.

If the current probe utility of your software of choice does not offer plotting capability, you can insert a small resistance (e.g., 0.1 Ω in value) in series with D_4 and probe the voltage drop across the resistor. The current waveform will then be a scaled version of the probed voltage waveform, and the scale factor is the reciprocal of the series resistance.

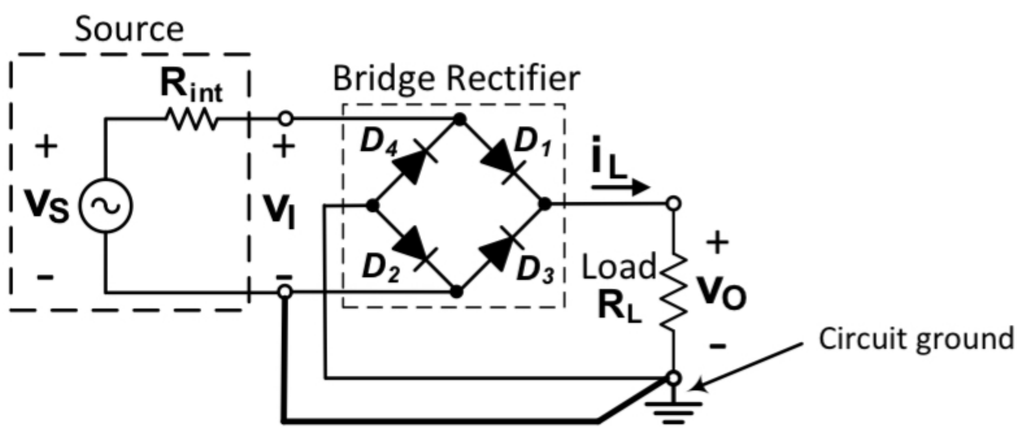
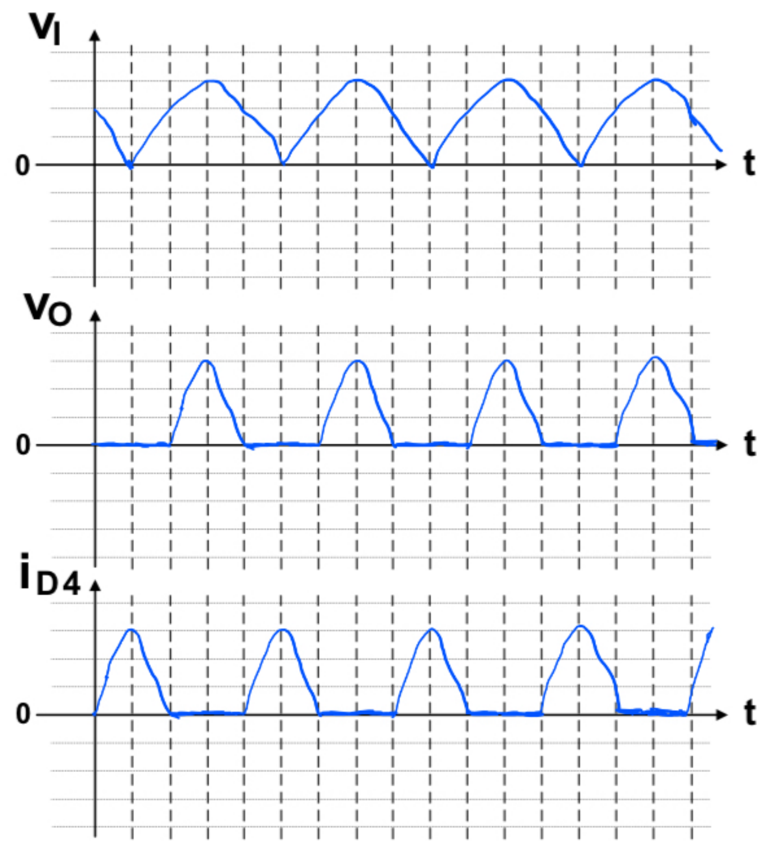


Figure 2. Bridge rectifier in which the circuit ground is shorted to the negative terminal of the source.



Graph P3. Waveforms of v_I, v_O, and i_{D4}, in the circuit of Figure 2.

P4. Consider the circuit of **Figure 3**, which is a bridge rectifier with a smoothing capacitor. Assume that the diodes are **1N4148** diodes, v_S has **a 500-Hz symmetrical sinusoidal waveform with a magnitude of 16 V peak-to-peak**, $\boldsymbol{C = 1\ \mu F}$. Then, calculate the average (DC) and peak-to-peak ripple of the output voltage, assuming that $\boldsymbol{R_L = 5.6\ k\Omega}$. For this exercise, ignore the source resistance (i.e., consider R_{int} to be a short link). Show all the work. Complete **Table P4**.

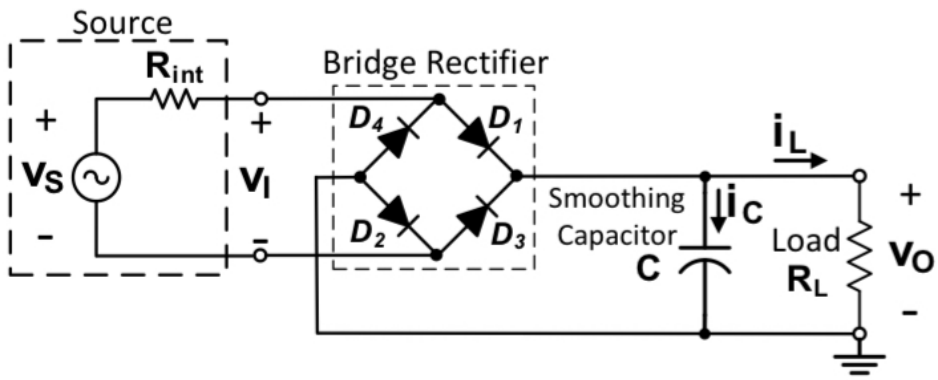
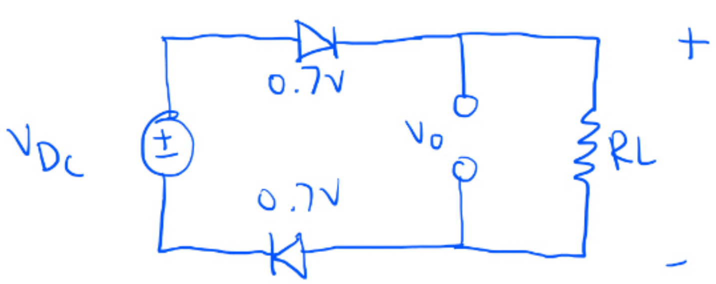


Figure 3. Bridge rectifier with smoothing capacitor.

Table P4. DC output voltage and peak-to-peak ripple

$\overline{v_O}$ $[V]$	V_r $[V]$
3.7V	2.86 V



$$T = \frac{1}{F} = \frac{1}{500} = 2 \times 10^{-3}\ s$$

$$\tau = RC = (5.6 \times 10^{3})(1 \times 10^{-6})$$
$$= 5.6 \times 10^{-3}\ s$$

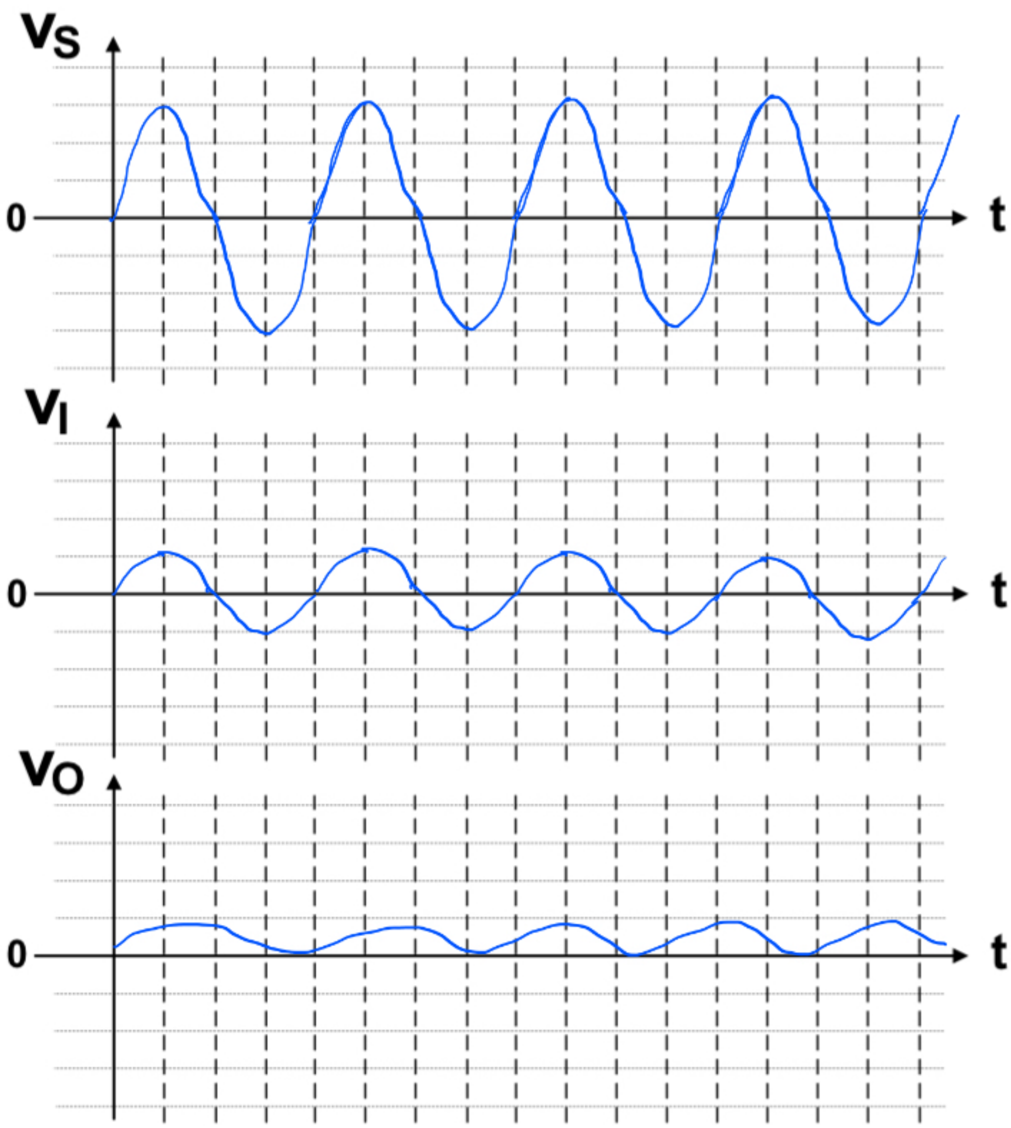
KVL:

$$V_{DC} = 2(0.7) + V_o$$
$$V_o = V_{DC} - 2(0.7)$$
$$= (0.637 \cdot 8) - 1.4$$
$$= 5.1 - 1.4$$
$$= 3.7\ V$$

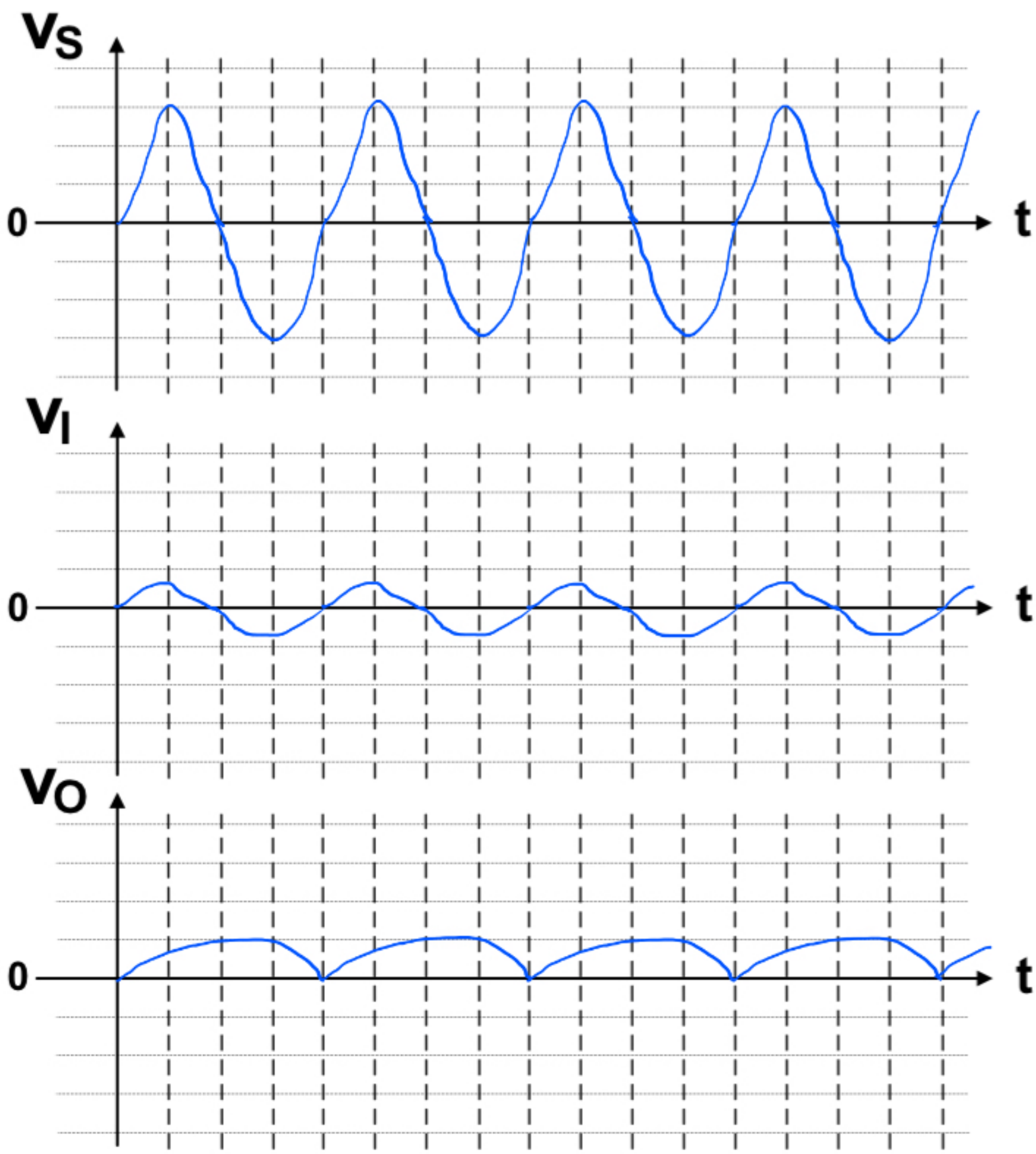
$$V_r = V_S \cdot \frac{T}{\tau}$$
$$= 8\left(\frac{2 \times 10^{-3}}{5.6 \times 10^{-3}}\right)$$
$$= 2.86\ V$$

Then, assuming $\boldsymbol{R_{int}} = \mathbf{50\ \Omega}$, simulate the circuit with $\boldsymbol{R_L} = \mathbf{5.6\ k\Omega}$ and capture the source, input, and output voltage waveforms for about three cycles. Present the waveforms as **Graph P4(a)**.

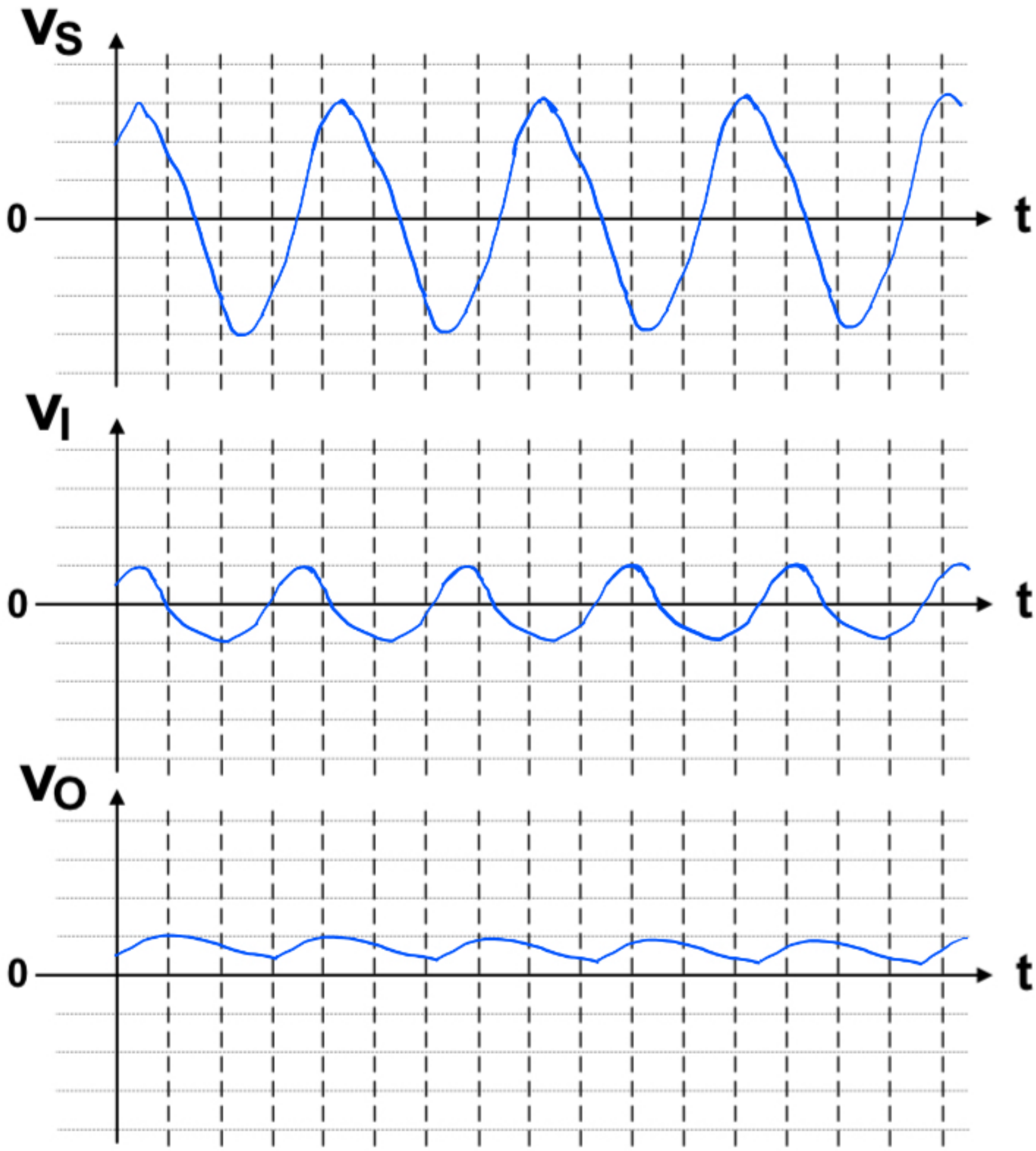
Repeat the simulation with $\boldsymbol{R_L} = \mathbf{56\ k\Omega}$ and $\boldsymbol{R_L} = \mathbf{560\ \Omega}$. Save the waveforms as **Graph P4(b)** and **Graph P4(c)**, respectively.



Graph P4(a). Source, input, and output voltage waveforms for the bridge rectifier with smoothing capacitor of Figure 3, with $\mathbf{R_{int} = 50\ \Omega}$ and $\mathbf{R_L = 5.6\ k\Omega}$.



Graph P4(b). Source, input, and output voltage waveforms for the bridge rectifier with smoothing capacitor of Figure 3, with $R_{int} = 50\ \Omega$ and $R_L = 56\ k\Omega$.



Graph P4(c). Source, input, and output voltage waveforms for the bridge rectifier with smoothing capacitor of Figure 3, with $R_{int} = 50\ \Omega$ and $R_L = 560\ \Omega$.