Laboratory Manual

EE-153L – Introduction to Electrical Engineering

Fall 2025

Instructor

Engr. Noman Khan

Lab Engineers

Engr. Bilal Haider
Engr. Yasir Kamal

Department of Electrical Engineering
Pakistan Institute of Engineering & Applied Sciences
Islamabad, Pakistan

Experiment 9

Half-Wave Diode Rectification

9.1 Objective

This lab involves the study of half-wave rectification using a diode, a sinusoidal signal from a function generator, and a load resistor. The experiment demonstrates how the diode permits current to flow only during the positive half-cycle of the input AC waveform, producing a pulsating DC output. The rectified signal will be observed and analyzed using an oscilloscope. Additionally, a capacitor will be connected in parallel with the load resistor to investigate its role as a smoothing filter. The capacitor charges during the conducting interval and discharges slowly through the load, thereby reducing ripple and providing a smoother, more stable DC output.

9.2 Theory Overview

A half-wave rectifier is the simplest form of AC-to-DC conversion, using a single diode to allow current flow during only one-half of the input sinusoidal cycle. When the input voltage becomes positive, the diode becomes forward-biased and conducts, producing a corresponding positive voltage across the load resistor. During the negative half-cycle, the diode is reverse-biased and blocks current, causing the output to drop to zero. This results in a pulsating DC signal with significant ripple. To improve the quality of the output, a capacitor can be placed in parallel with the load. The capacitor charges to the peak voltage when the diode conducts and discharges during the non-conducting interval, thereby smoothing the waveform and increasing the average DC level. Understanding the behavior of the diode and the effect of the filtering capacitor is essential for analyzing rectification circuits used in power supplies and signal conditioning applications.

9.2.1 Pre-Lab Task

Before performing the experiment in the laboratory, complete the following tasks in LTspice to demonstrate your understanding of the theoretical concepts. These preparatory tasks will help you predict circuit behavior and verify your results during the lab session.

9.3 Equipment

- Function Generator
- Oscilloscope
- Digital Multimeter
- Diode
- Load Resistor (1 kΩ)
- Breadboard and connecting wires

9.4 Schematics

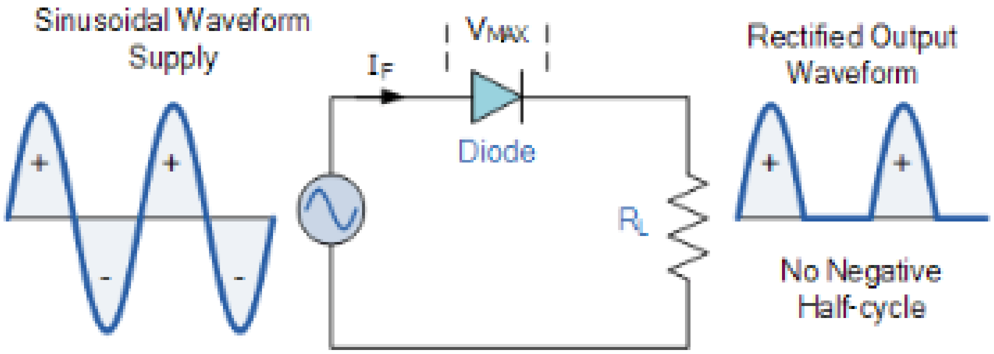

Fig 9.1

9.5 Procedure

To begin the experiment, configure the function generator to provide a 5 V peak (or 5 Vpp) sinusoidal signal at a frequency of 1 kHz and verify the waveform using the oscilloscope. Construct the half-wave rectifier circuit on the breadboard using a diode and a 1 kΩ load resistor, ensuring that the diode is oriented correctly for forward conduction during the positive half-cycle. Connect Channel 1 of the oscilloscope to the input signal to continuously monitor the applied sine wave, and connect Channel 2 across the load resistor to observe the rectified output waveform. Using the theoretical relation

$$V_{out,\ peak} \approx V_{in,\ peak} - V_D$$

Calculate the expected peak output voltage, where V_D represents the diode's forward voltage drop. After powering the circuit, measure and record the actual peak output voltage and the corresponding waveform shape displayed on the oscilloscope. Finally, compute the deviation between the theoretical and measured values and analyze potential sources of error such as diode drop variation, instrument accuracy, or breadboard wiring losses.

9.6 Data Tables

Parameter	**Theory**	**Measured**
Peak Input Voltage (V)		
Peak Output Voltage (V)		
Diode Forward Drop (V)		

Table 9.1

9.7 Questions

1. Why does the diode conduct only during the positive half-cycle?

2. How does the diode forward voltage drop affect the output waveform?

3. What changes occur in the output if the load resistance is increased?

4. How would adding a capacitor across the load change the output waveform?

5. Why is half-wave rectification considered inefficient?

9.8 Conclusion

Assessment

Sr. No.	Specific Course Learning Outcomes	Knowledge Domains	Performance indicator
	Upon completion of this course, the students will be able to		
1	**USE** electronic lab instruments including the digital multi-meter, function generator, oscilloscope and electronic circuit trainer.	P1	• Proper wiring of the circuit • Correct use of instruments (signal generator, oscilloscope) • Data recorded in table
2	**CONSTRUCT** and **ANALYZE** basic circuits.	P2	• Relate experiment with theoretical concept discussed in class. • Describe relevant mathematical equations • Discuss discrepancies between theoretical, simulation and experimental results • Possible sources of discrepancies and ways to improve
3	**COMMUNICATE** clearly and effectively through presentation and/or report	A2	• Report is structured properly • Figures and Graphs annotated • Language is clear
4	**DEMONSTRATE** teamwork and show commitment to the group in achieving the objectives of laboratory	A2	• Does his/her part in the group • Listen to other's ideas • Does not argue
5	**DEMONSTRATE** punctuality, dress appropriately and comply with the standard safety procedures of the lab	A2	• Wear proper dress to perform the tasks and Follow lab timing • Follow safety instructions for handling the instruments.