PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of Electrical & Electronic Engineering

Lab Assignment

COURSE CODE: EEE-4110

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Experiment No: 01

Experiment Name: Simulation of diode circuit with DC source and RC load using MATLAB Simulink.

Apparatus Required:

1. DC voltage source
2. Stair generator
3. Ideal switch
4. Diode
5. Resistor
6. Capacitor
7. Voltage measurement
8. Scope

Circuit diagram:

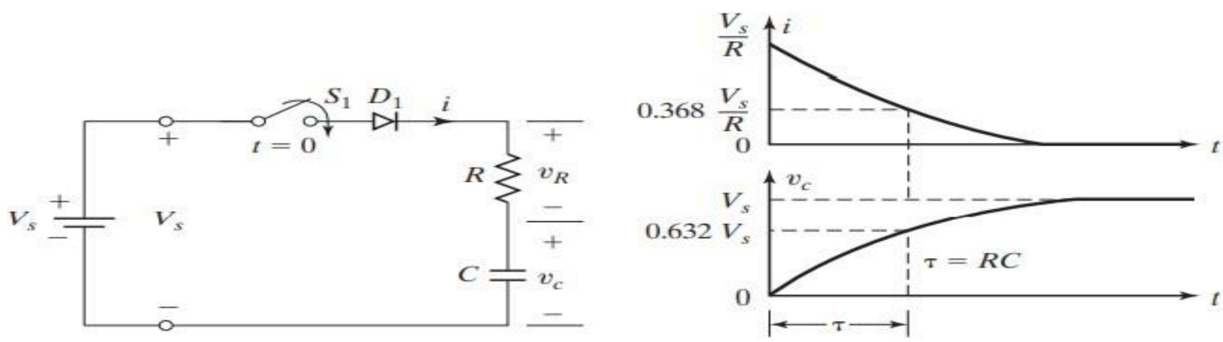


Figure 1.1: MATLAB Simulation diagram of Diode circuit with DC source and RC load.

MATLAB Model:

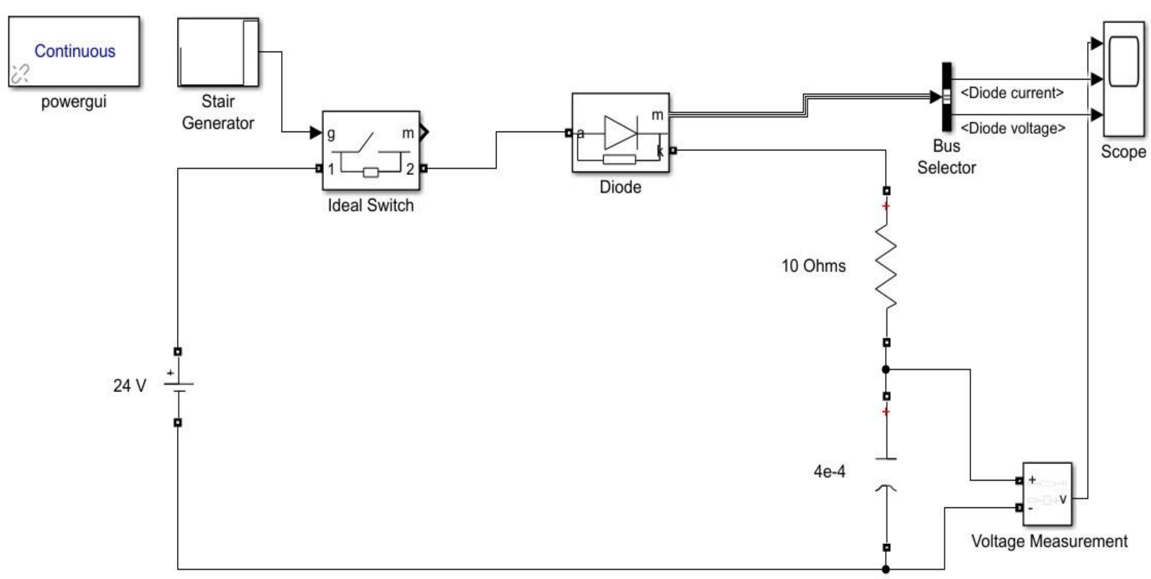


Figure 1.2: MATLAB Simulation diagram of Diode circuit with DC source and RC load.

Results:

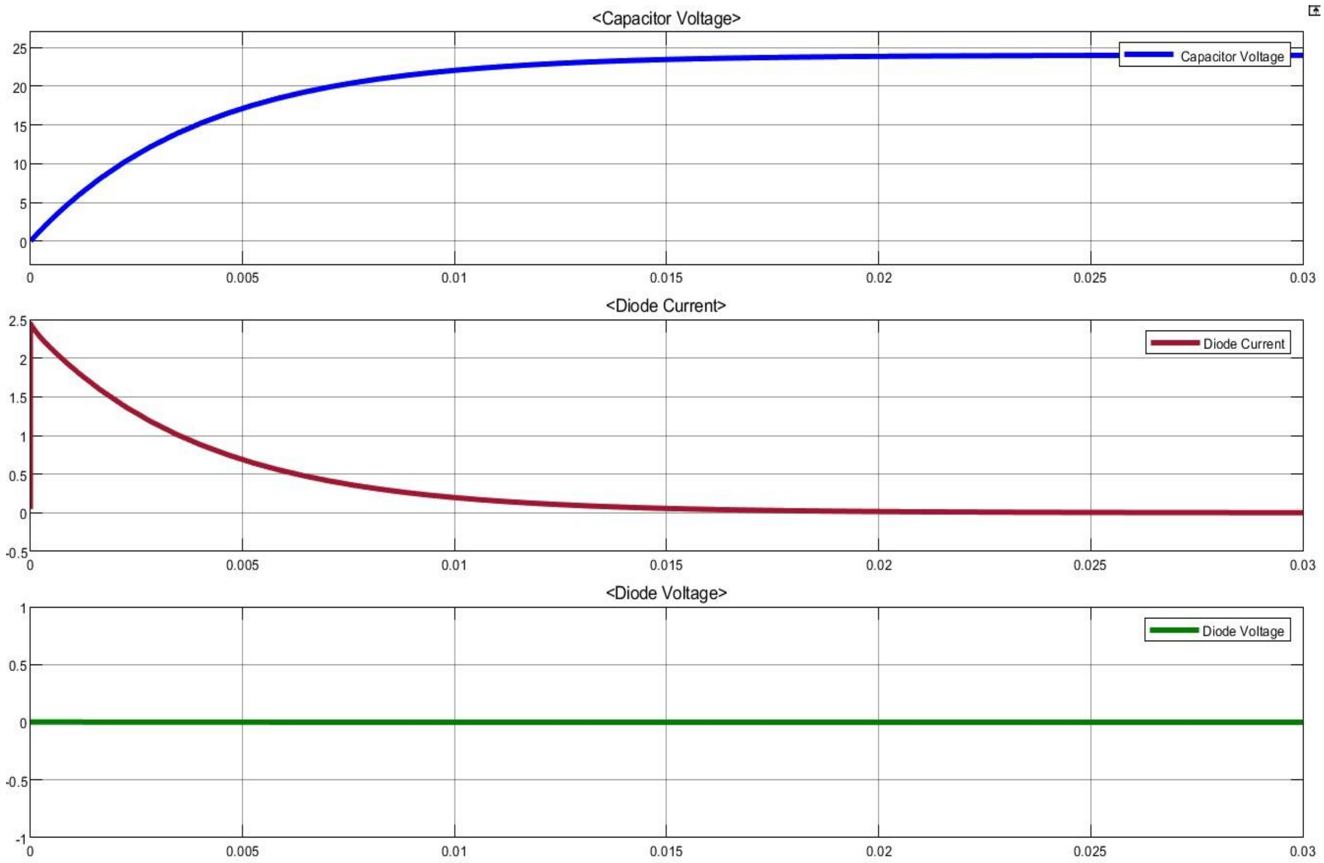


Figure 1.3: MATLAB Simulation diagram of Diode circuit with DC source and RC load.

Discussion:

This experiment involved the simulation of a diode circuit with a direct current source and a resistive-capacitive load. The graph indicates that the capacitor voltage progressively rises and eventually stabilizes at a specific value. As the capacitor charges, the current through the diode flows and diminishes progressively. When the capacitor reaches full charge, the current flowing through the diode ceases. The circuit's principal characteristic is the progressive charging of the capacitor, resulting in a voltage increase that ultimately stabilizes.

Experiment No: 02

Experiment Name: Simulation of diode circuit with DC source and RL load using MATLAB Simulink.

Apparatus Required:

1. DC voltage source
2. Stair generator
3. Ideal switch
4. Diode
5. Resistor
6. Inductor
7. Voltage measurement
8. Scope

Circuit Diagram:

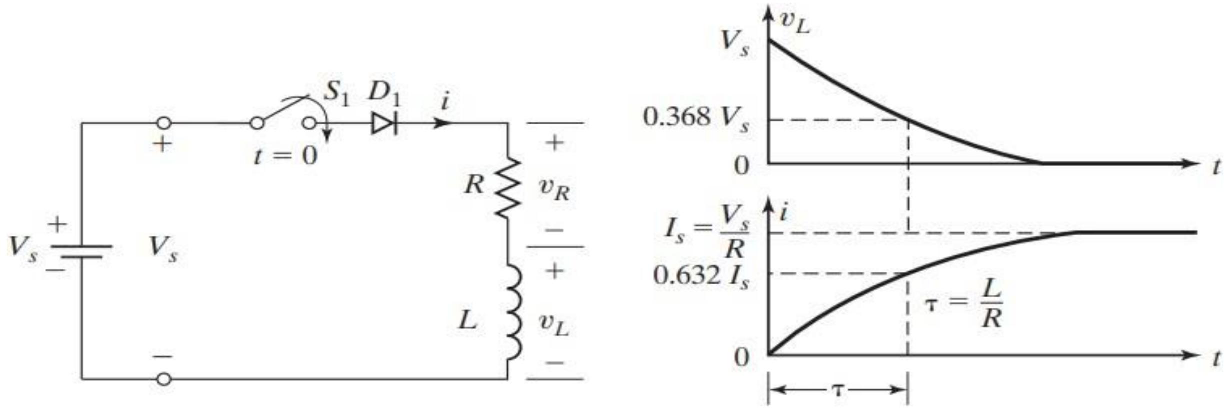


Figure 2.1: MATLAB Simulation diagram of Diode circuit with DC source and RL load.

MATLAB Model:

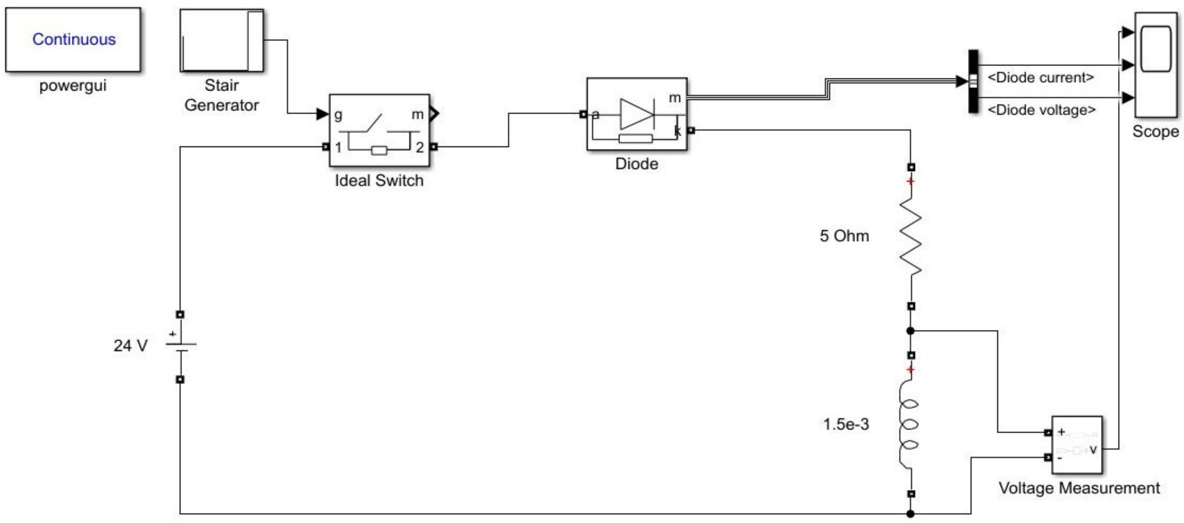


Figure 2.2: MATLAB Simulation diagram of Diode circuit with DC source and RL load.

Results:

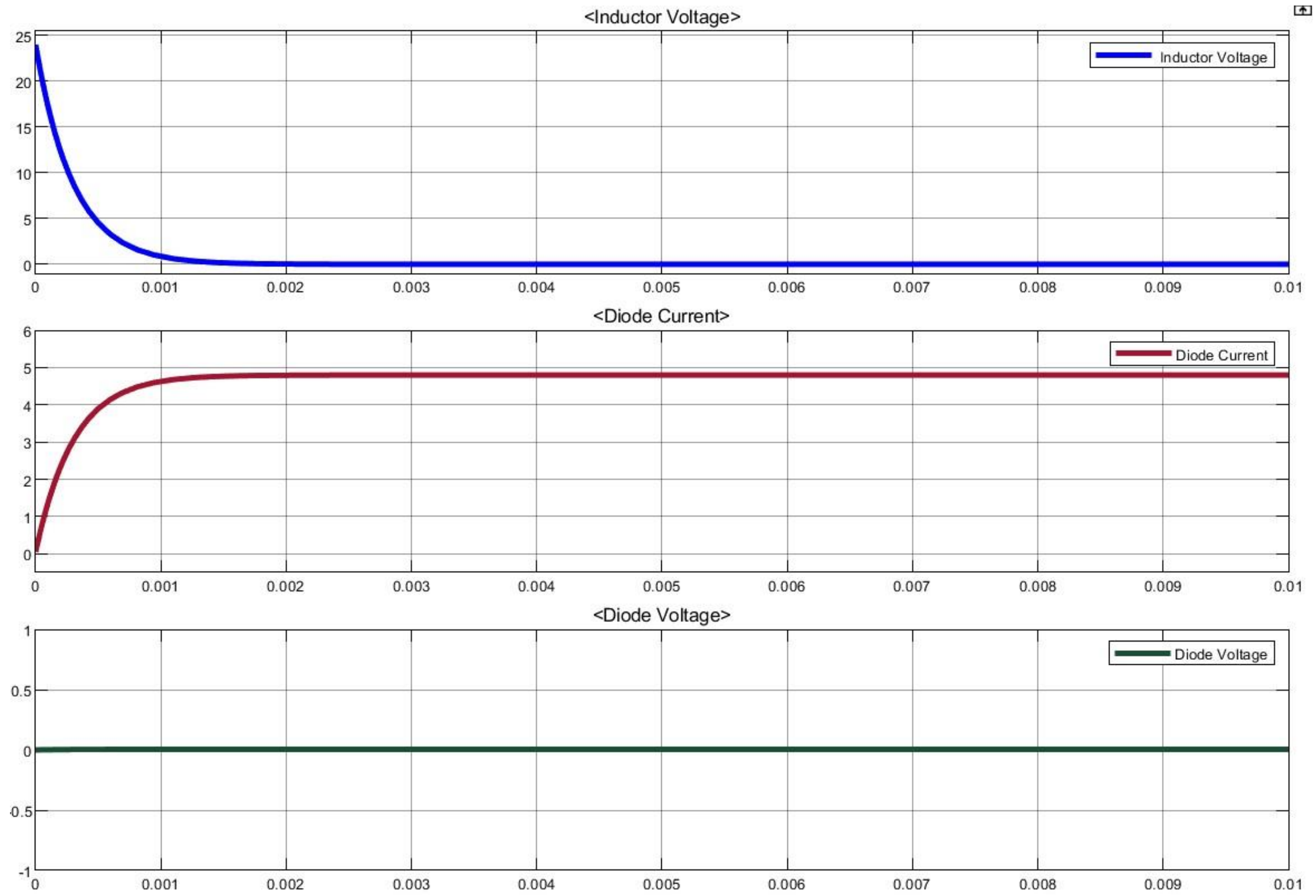


Figure 2.3: MATLAB Simulation diagram of Diode circuit with DC source and RL load.

Discussion:

This experiment involves the simulation of a diode circuit with an RL load. The graph illustrates a gradual decline in inductor voltage, concurrently with a rise in diode current that stabilizes at a constant level. The fundamental function of the inductor is to store energy and subsequently release it gradually into the circuit. Upon energization of the circuit, the inductor accumulates energy, which is then released over time, resulting in current stabilization.

Experiment No: 03

Experiment Name: Simulation of diode circuit with DC source and LC load using MATLAB Simulink

Apparatus Required:

1. DC voltage source
2. Stair generator
3. Ideal switch
4. Diode
5. Capacitor
6. Inductor
7. Voltage measurement
8. Scope

Circuit Diagram:

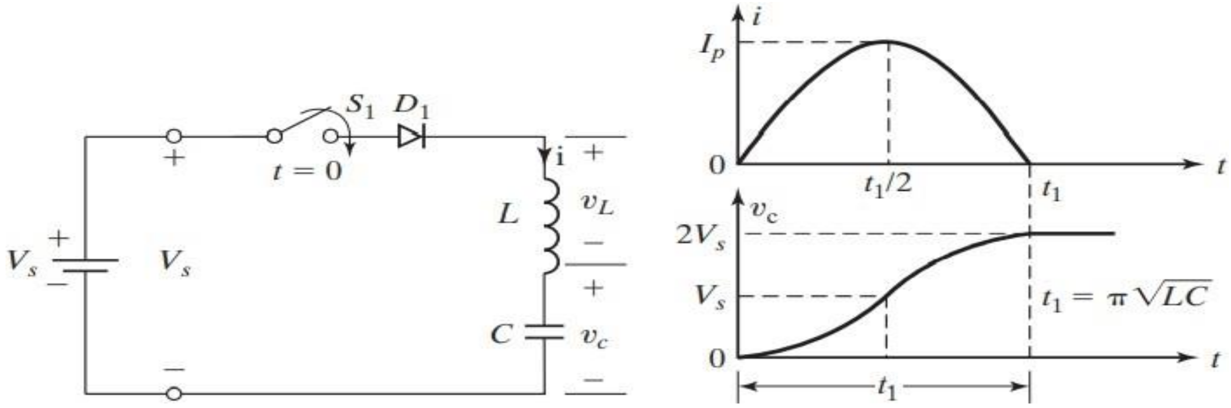


Figure 3.1: MATLAB Simulation diagram of Diode circuit with DC source and LC load.

MATLAB Model:

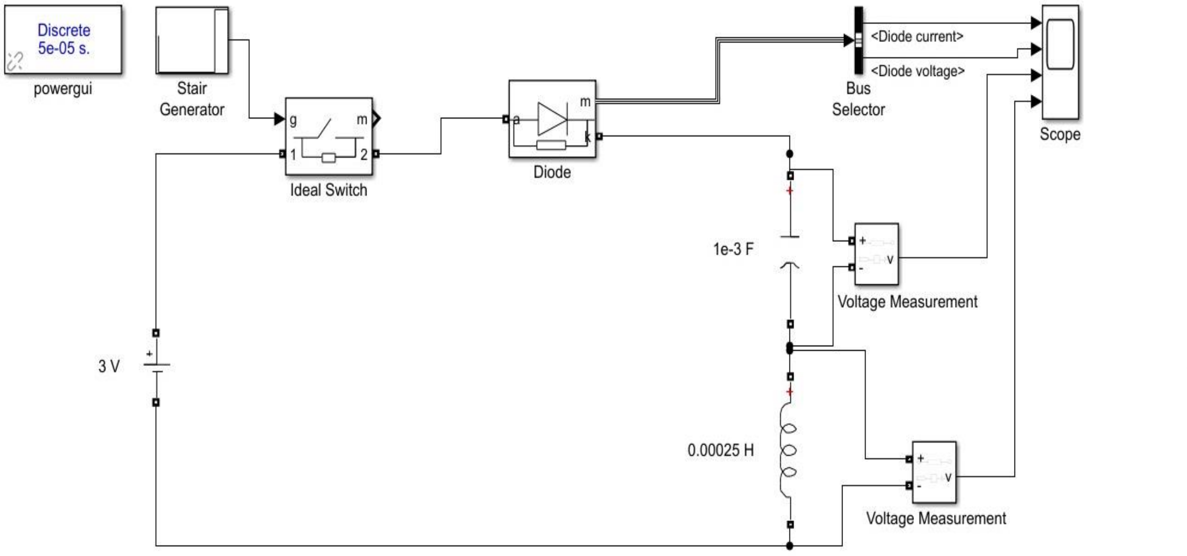


Figure 3.2: MATLAB Simulation diagram of Diode circuit with DC source and LC load.

Results:

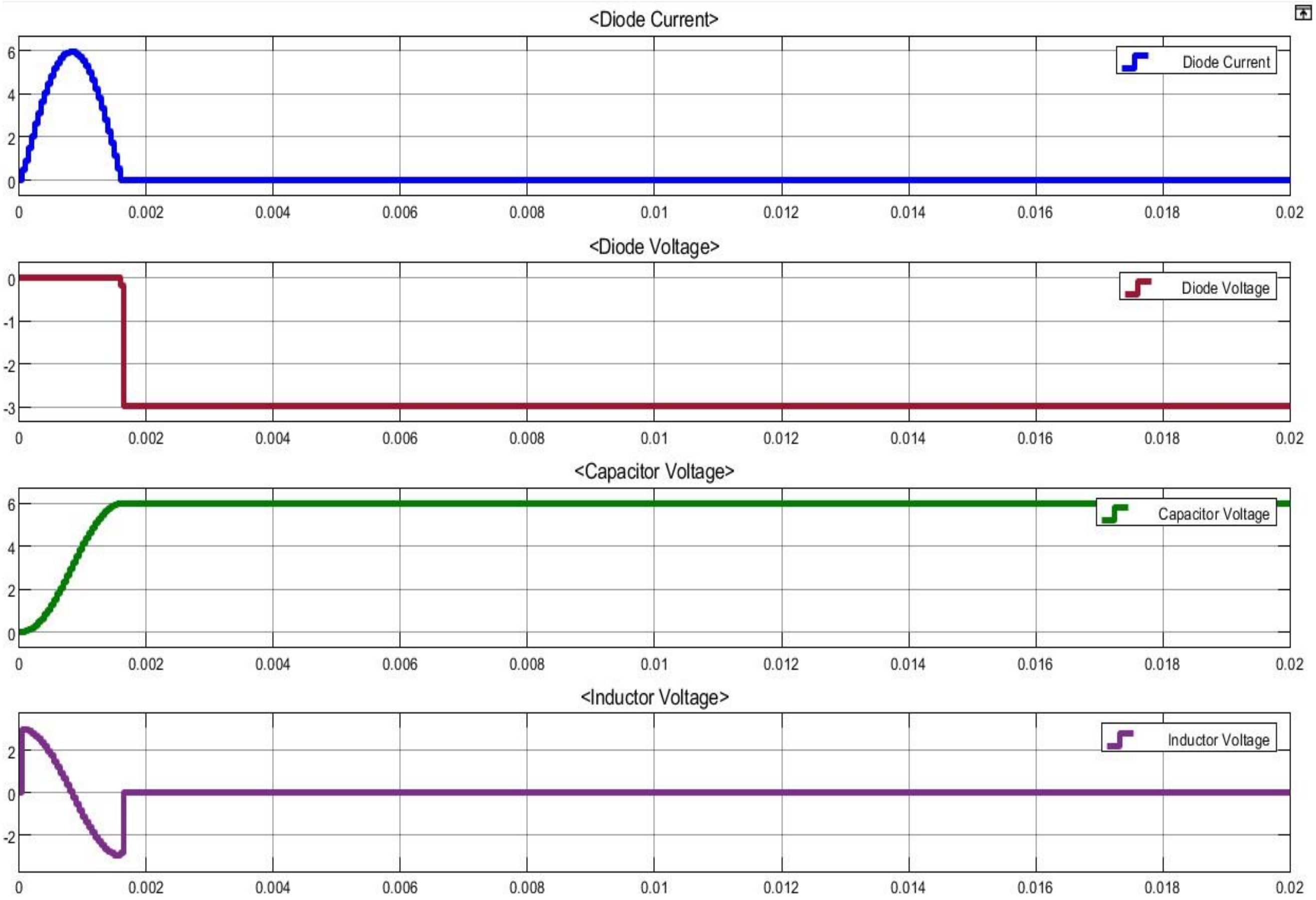


Figure 3.3: MATLAB Simulation diagram of Diode circuit with DC source and LC load.

Discussion:

This experiment involves the simulation of a diode circuit with an LC load. As there is an absence of a resistor (R) in the circuit, energy loss is nonexistent. Consequently, the voltage across the capacitor rises and attains stability over time. The graph additionally illustrates the oscillating current and voltage of the inductor and capacitor. This illustrates that energy in the LC circuit is transferred between the capacitor and the inductor, resulting in oscillations without energy dissipation.

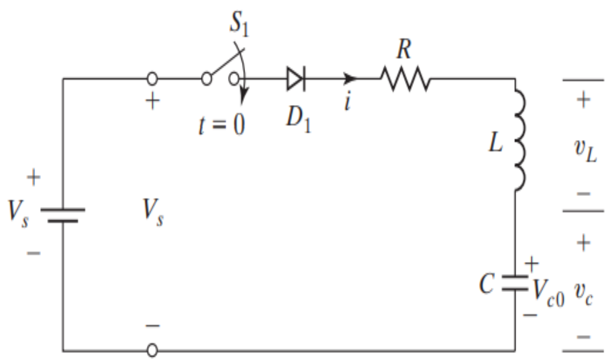
Experiment No: 04

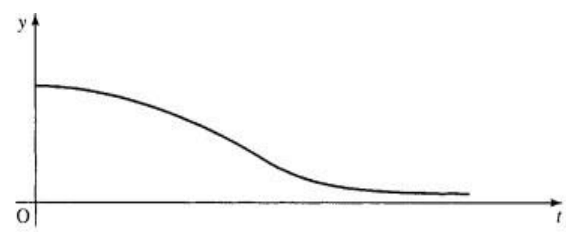
Experiment Name: Simulation of diode circuit with DC source and RLC load using MATLAB Simulink.

Apparatus Required:

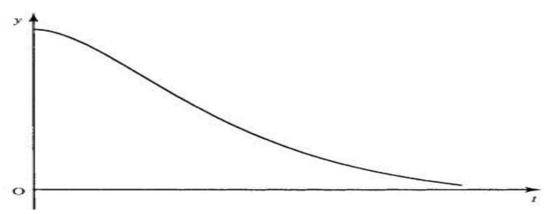
1. DC voltage source
2. Diode
3. Resistor
4. Inductor
5. Capacitor
6. Current measurement
7. Scope

Circuit Diagram:

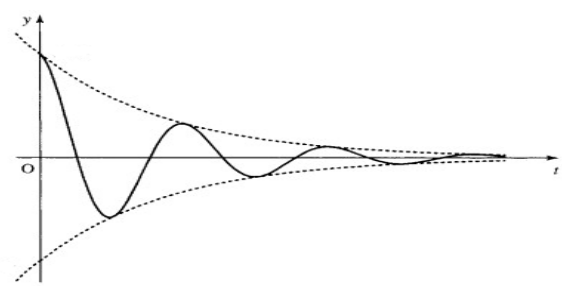




Critically damped



Over damped



Underdamped

Figure 4.1: MATLAB Simulation diagram of Diode circuit with DC source and RLC load.

MATLAB Model:

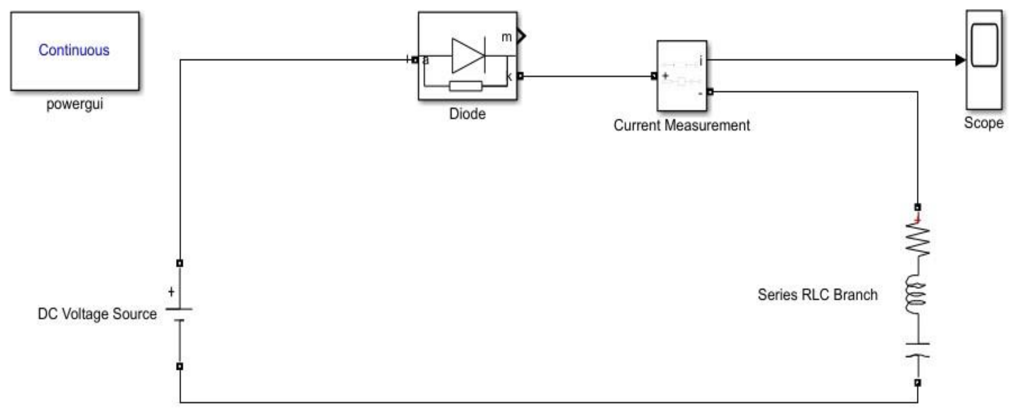


Figure 4.2: MATLAB Simulation diagram of Diode circuit with DC source and RLC load.

Results:

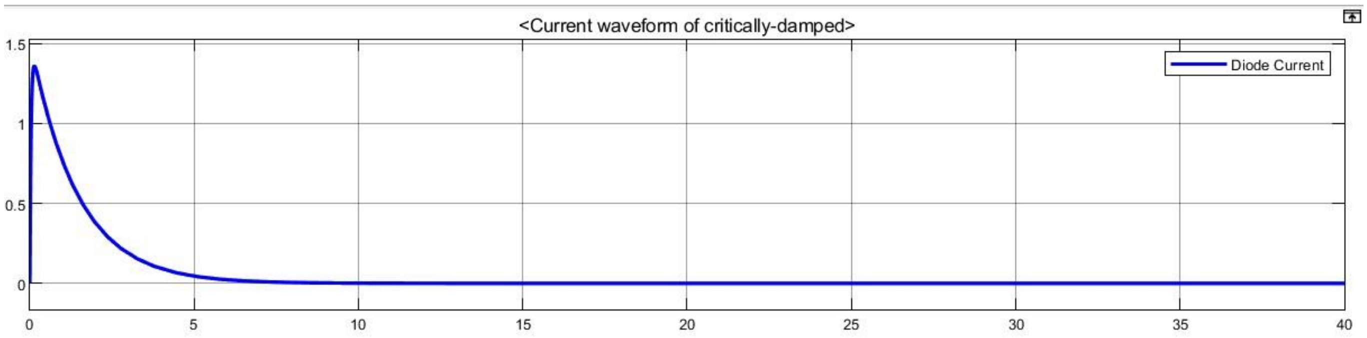


Figure 4.3: Current waveform of critically-damped circuit (R=20 Ohms, L=0.73 H, C=0.072985 F, α=13.7, ω_0=13.7, $\alpha=\omega_0$)

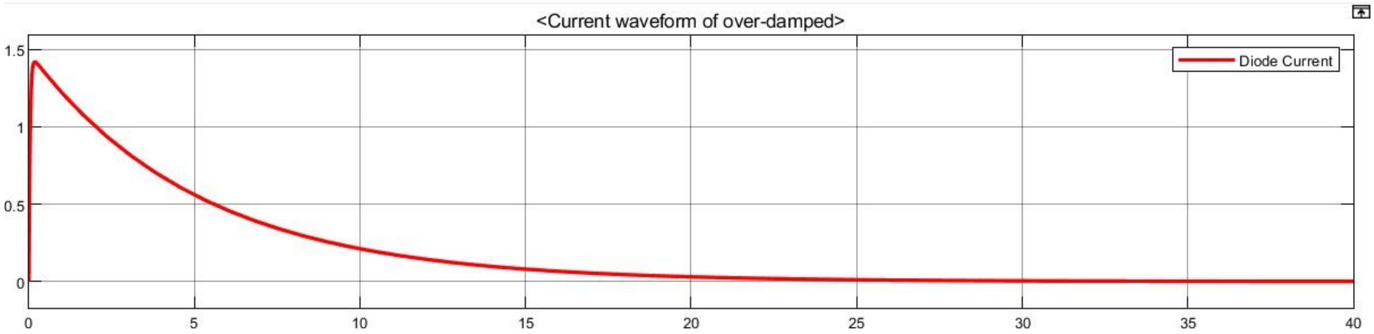


Figure 4.4: Current waveform of over-damped circuit (R=20 Ohms, L=0.73 H, C=0.258953 F, α=13.7, ω_0=2.30, $\alpha>\omega_0$)

Figure 4.4: Current waveform of under-damped circuit (R=20 Ohms, L=0.73 H, C=1uF, α=13.7, ω_0=1170.41, $\alpha<\omega_0$)

Discussion:

This experiment involved the simulation of a diode circuit with an RLC load. The three categories of damping conditions critically damped, overdamped, and underdamped have been examined. In a severely damped circuit, the current rapidly approaches zero; in an overdamped circuit, the current diminishes gradually; and in an underdamped circuit, the current exhibits oscillations. The resistor, inductor, and capacitor in this circuit together generate varying current behaviors under different conditions. The graph clearly illustrates the present behavior under each condition.

Experiment No: 05

Experiment Name: Simulation of diode circuit with DC source and RL Load including Freewheeling diode using MATLAB Simulink.

Apparatus Required:

1. DC voltage source
2. Stair generator
3. Ideal switch
4. Diode
5. Freewheeling diode
6. Resistor
7. Inductor
8. Current measurement
9. Multimeter
10. Scope

Circuit Diagram:

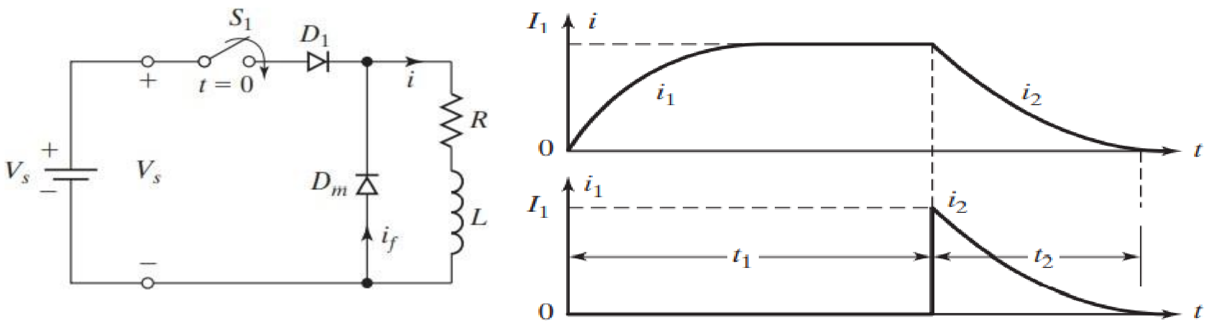


Figure 5.1: MATLAB Simulation diagram of Diode circuit with DC source and RL Load including Freewheeling diode.

MATLAB Model:

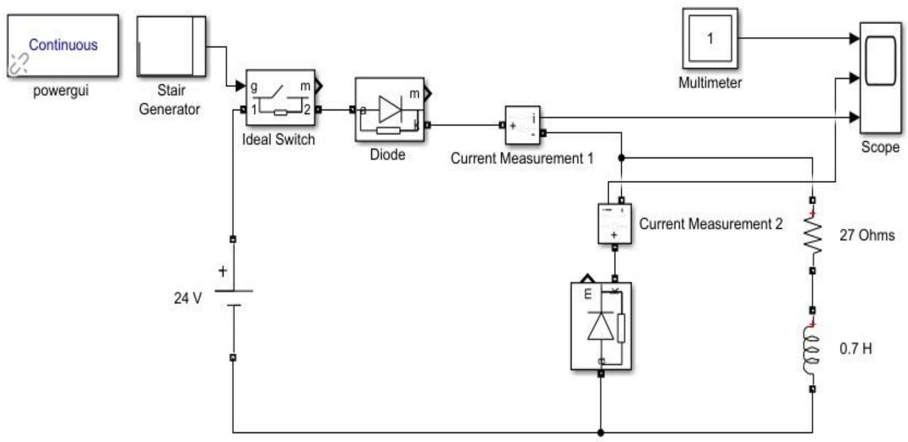


Figure 5.2: MATLAB Simulation diagram of Diode circuit with DC source and RL Load including Freewheeling diode.

Results:

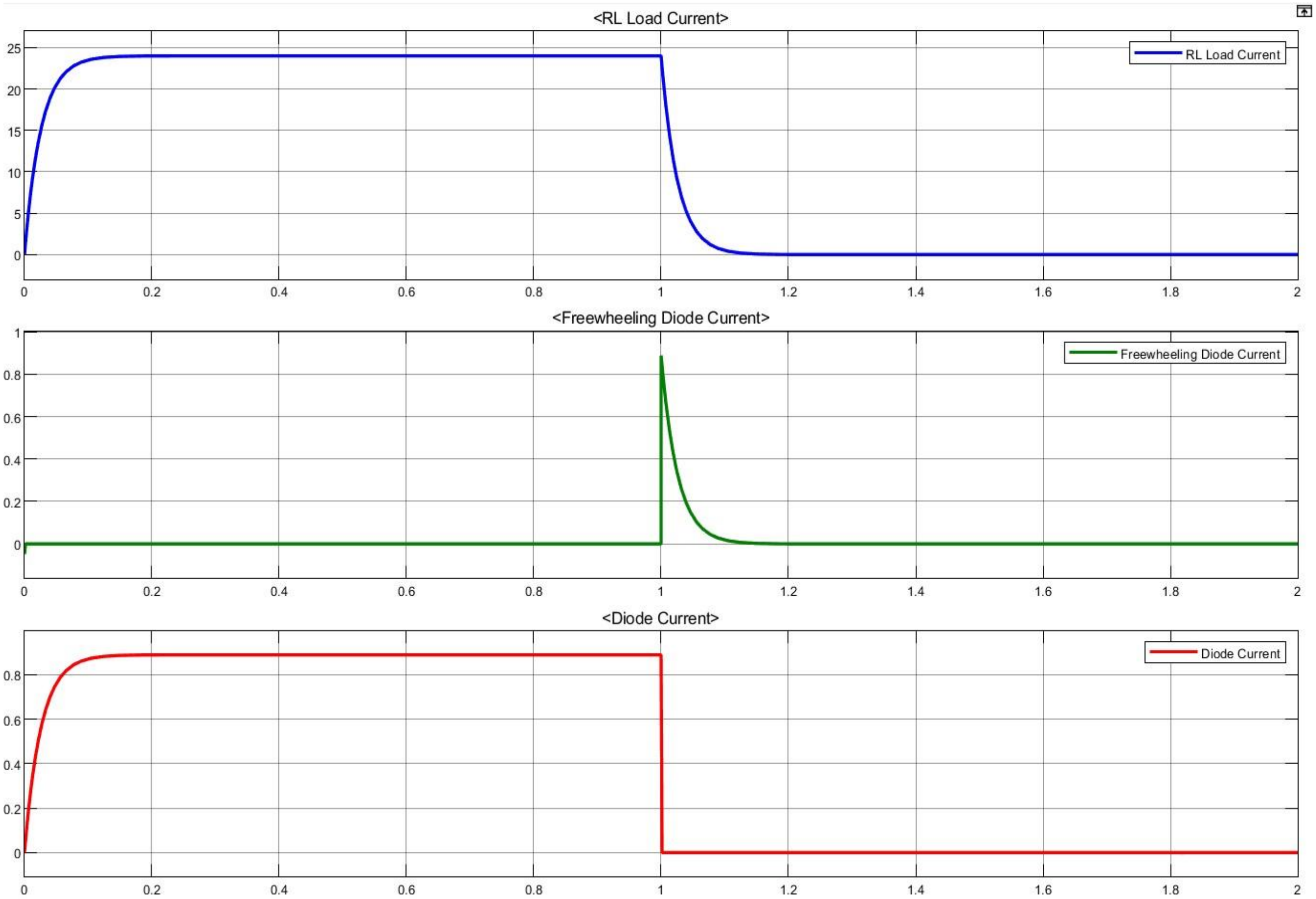


Figure 5.3: MATLAB Simulation diagram of Diode circuit with DC source and RL Load including Freewheeling diode.

Discussion:

This experiment simulates an RL load equipped with a freewheeling diode. The function of the freewheeling diode is to offer a secondary pathway for the inductive load current when the primary diode is deactivated. This diode safeguards the circuit from damage and inhibits sparking in the circuit switch. The graph illustrates the current flowing between the freewheeling diode and the primary diode. The freewheeling diode guarantees uninterrupted current flow in the circuit, offering protection and averting circuit failure.

Experiment No: 06

Experiment Name: Simulation of Single-Phase Half Wave Rectifier with RL Load Using MATLAB Simulink.

Apparatus Required:

9. AC voltage source
10. Powergui
11. Diode
12. Resistor
13. Inductor
14. Voltage measurement
15. Scope

Circuit diagram:

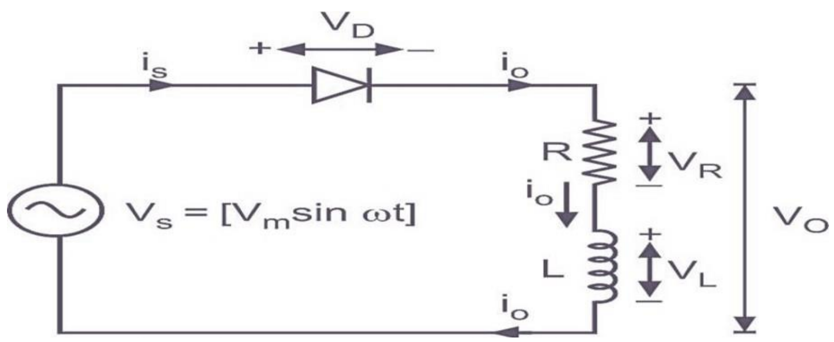


Figure 6.1: Circuit diagram of Single-Phase Half Wave Rectifier with RL Load.

MATLAB Model:

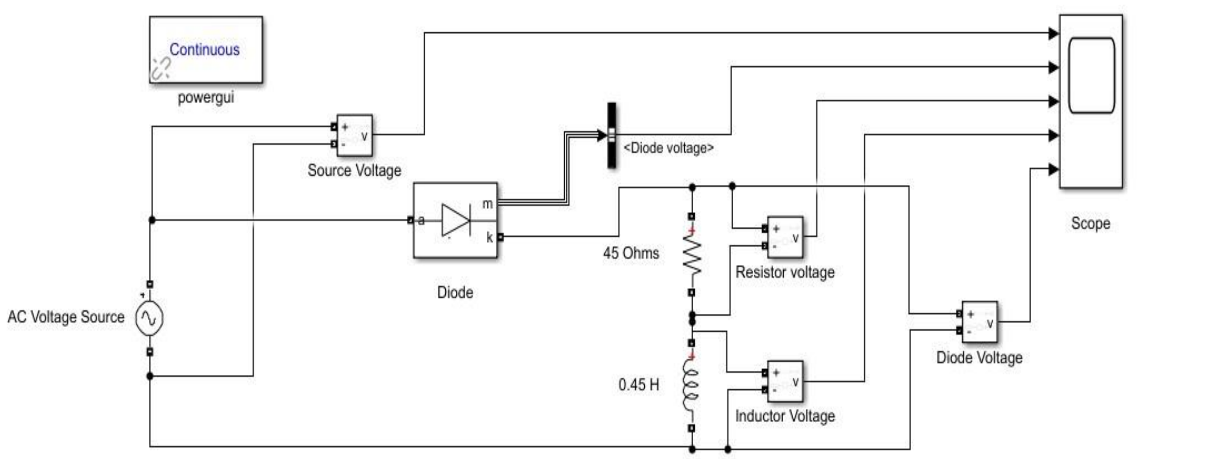


Figure 6.2: MATLAB circuit diagram of Single-Phase Half Wave Rectifier with RL Load.

Results:

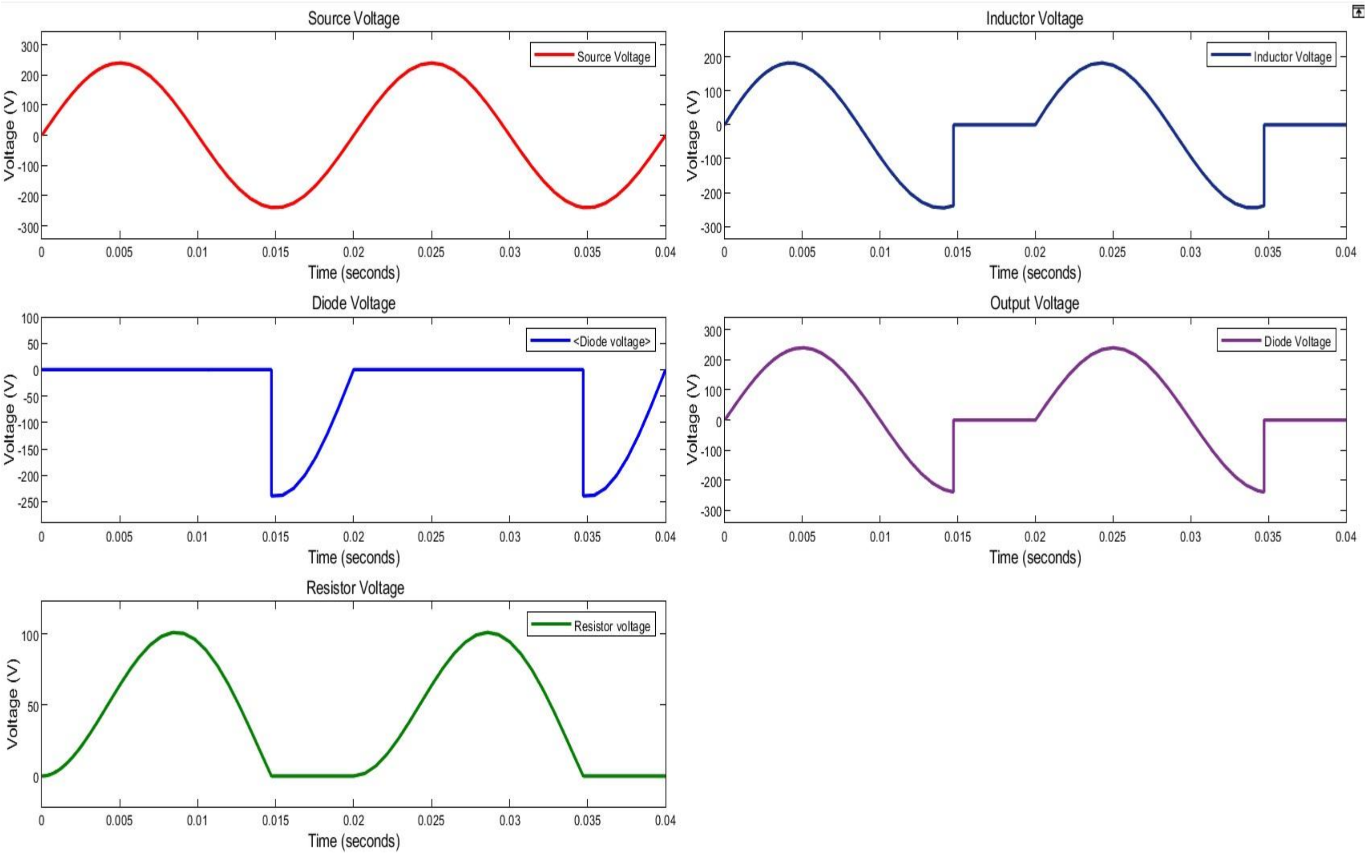


Figure 6.3: MATLAB Simulation Signal diagram of Single-Phase Half Wave Rectifier with RL Load.

Discussion:

The simulation demonstrates the behavior of a single-phase half-wave rectifier with an RL load. Here, the input voltage, resistor voltage, output voltage, and diode voltage waveforms are displayed. Due to the inductive nature of the load, the conduction period of the diode extends beyond 180 degrees, persisting until the current reaches zero. This phenomenon highlights how inductance prolongs the diode's conduction, effectively smoothing out the output current and reducing fluctuations.

Experiment No: 07

Experiment Name: Simulation of Single-Phase Half Wave Rectifier with RL Load Including Freewheeling Diode Using MATLAB Simulink.

Apparatus Required:

9. AC voltage source
10. Diode
11. Powergui
12. Resistor
13. Inductor
14. Voltage measurement
15. Scope

Circuit Diagram:

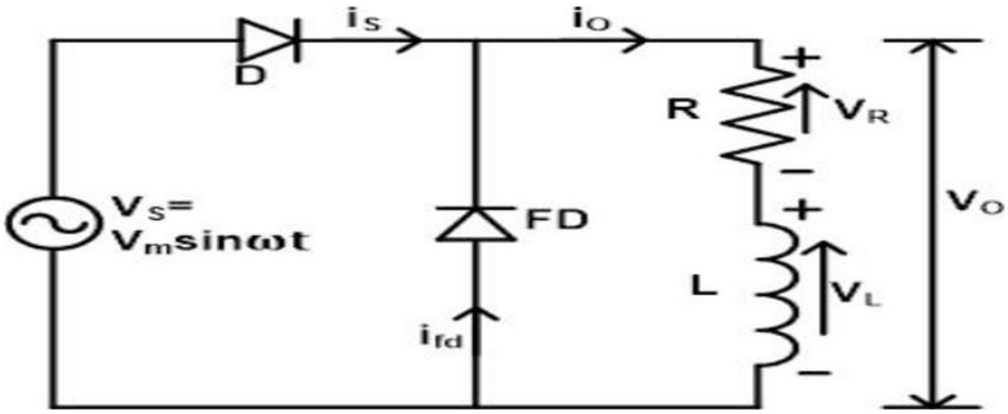


Figure 7.1: Circuit diagram of Single-Phase Half Wave Rectifier with RL Load with Freewheeling Diode.

MATLAB Model:

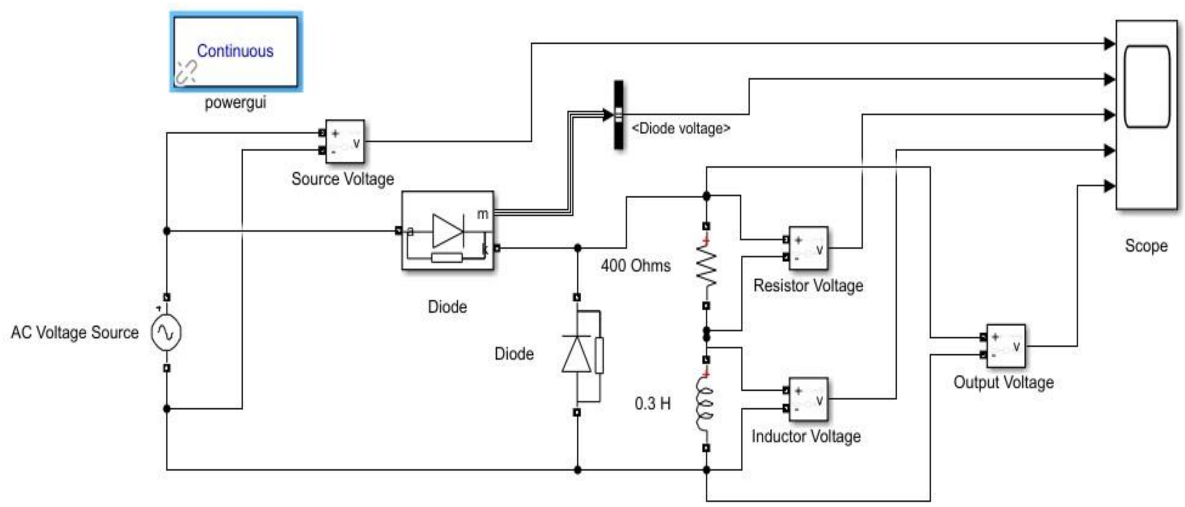


Figure 7.2: MATLAB diagram of Single-Phase Half Wave Rectifier with RL Load With Freewheeling Diode.

Results:

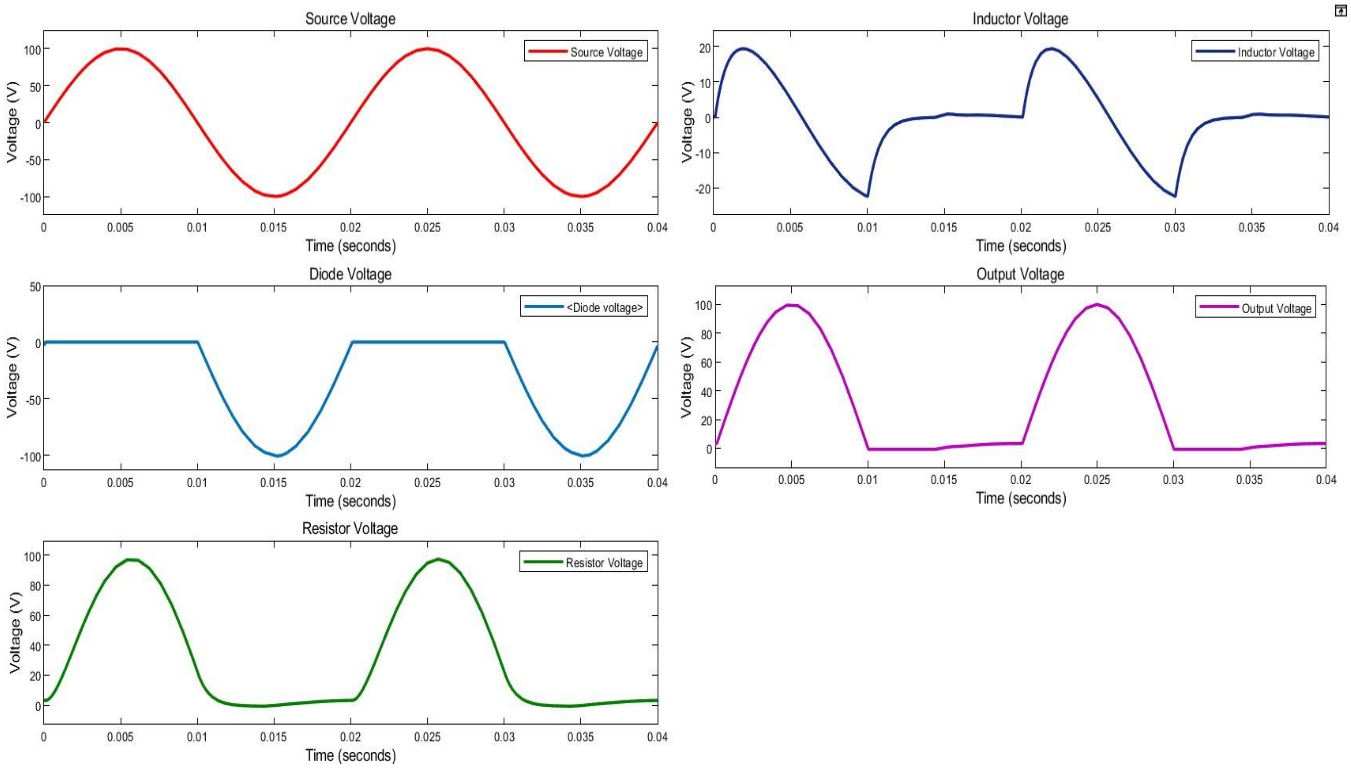


Figure 7.3: MATLAB Simulation Signal diagram of Single-Phase Half Wave Rectifier & RL Load With Freewheeling Diode.

Discussion:

In this simulation of a single-phase half-wave rectifier with an RL load, incorporating a freewheeling diode introduces a crucial improvement. Using MATLAB Simulink, the source voltage, diode voltage, and output voltage curves are obtained, showing enhanced current flow. During the negative half-cycle, the primary diode ceases conduction, and the freewheeling diode takes over, driven by the inductor's stored energy. This allows for smoother current transitions, which prevents sudden drops, optimizing the circuit’s efficiency and ensuring continuous power delivery.

Experiment No: 08

Experiment Name: Simulation of Single Phase Full-wave Rectifier with Center -tapped Transformer Using MATLAB Simulink.

Apparatus Required:

9. AC voltage source
10. Resistor
11. Linear transformer
12. Diode
13. Powergui
14. Sum
15. Voltage measurement
16. Scope

Circuit Diagram:

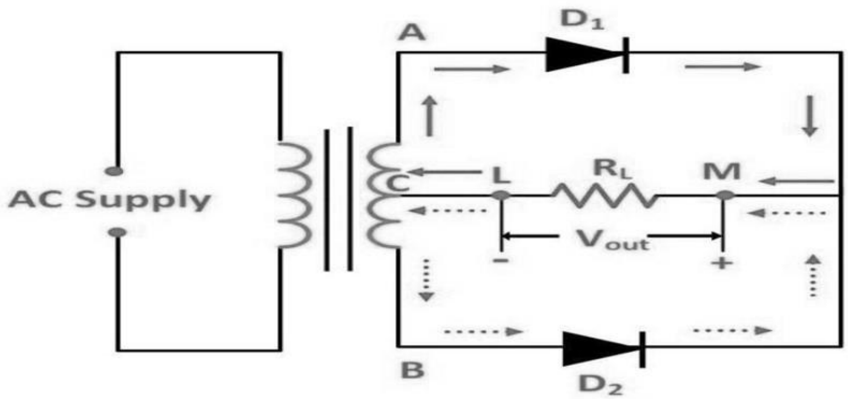


Figure 8.1: Circuit diagram of Single Phase Full-wave Rectifier with center-tapped Transformer.

MATLAB Model:

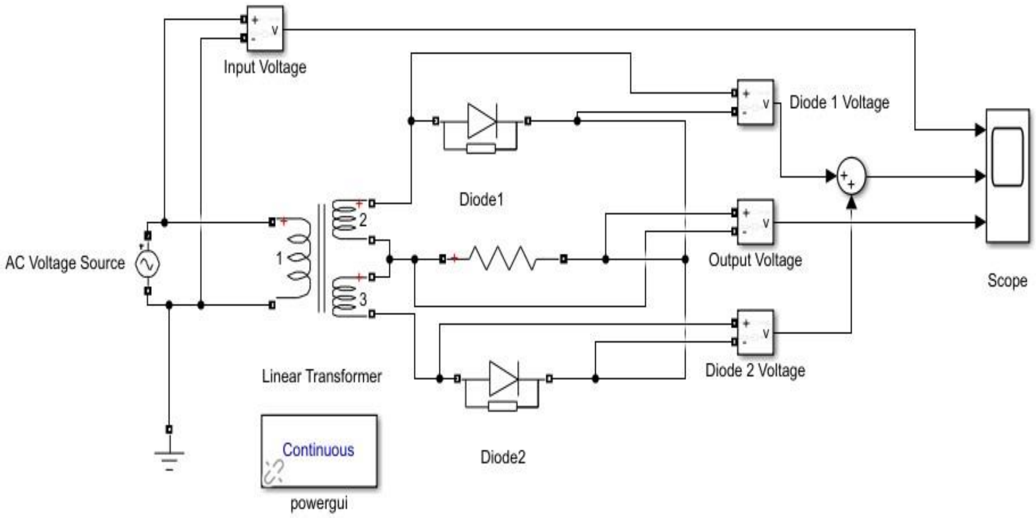


Figure 8.2: MATLAB diagram of Single Phase Full-wave Rectifier with center-tapped Transformer.

Results:

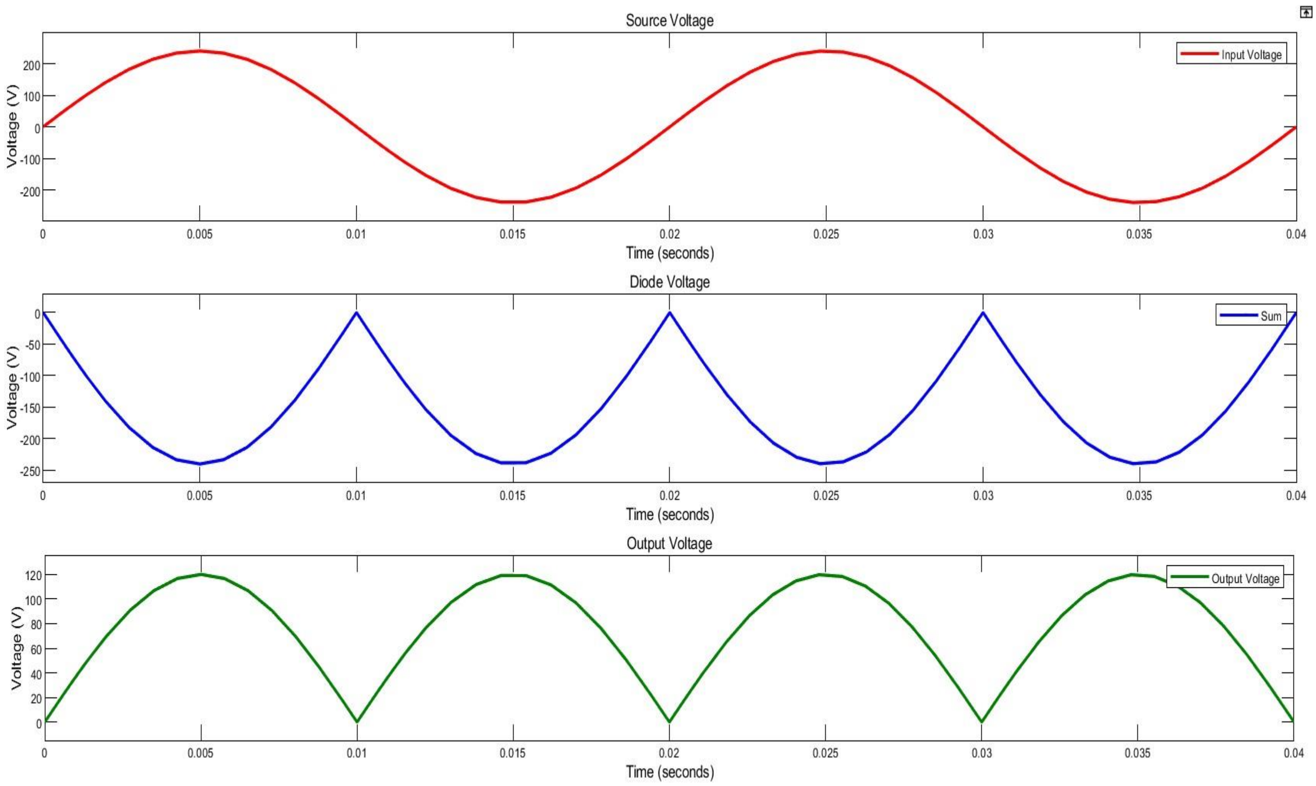


Figure 8.3: MATLAB Simulation diagram of Single Phase Full-wave Rectifier with Center -tapped Transformer.

Discussion:

The center-tapped full-wave rectifier simulation offers insights into dual-diode conduction across positive and negative input cycles. This setup allows for continuous rectification as, during the positive half-cycle, the first diode conducts while the second remains non-conductive, and the roles switch during the negative half-cycle. The resulting output voltage is more consistent and efficient, doubling the frequency of the rectified output, which makes it especially suitable for applications requiring stable DC power with minimized ripple.

Experiment No: 09

Experiment Name: Simulation of Single Phase Full-Wave Bridge Rectifier with RL Load Using MATLAB Simulink.

Apparatus Required:

8. AC voltage source
9. Diode
10. Resistor
11. Inductor
12. Voltage measurement
13. Current measurement
14. Scope

Circuit Diagram:

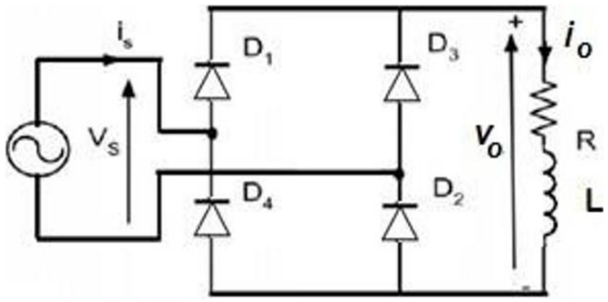


Figure 9.1: Circuit diagram of Single Phase Full-wave Bridge Rectifier with RL Load.

MATLAB Model:

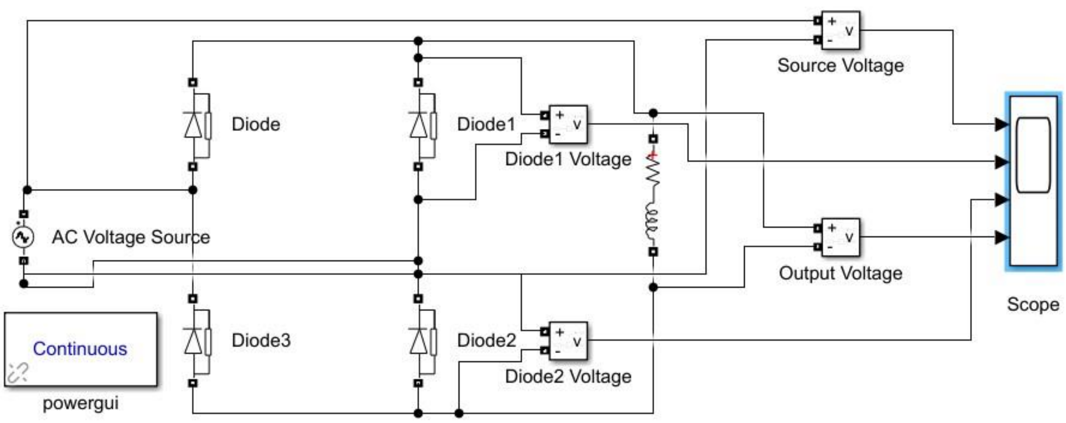


Figure 9.2: MATLAB Circuit diagram of Single Phase Full-wave Bridge Rectifier with RL Load.

Results:

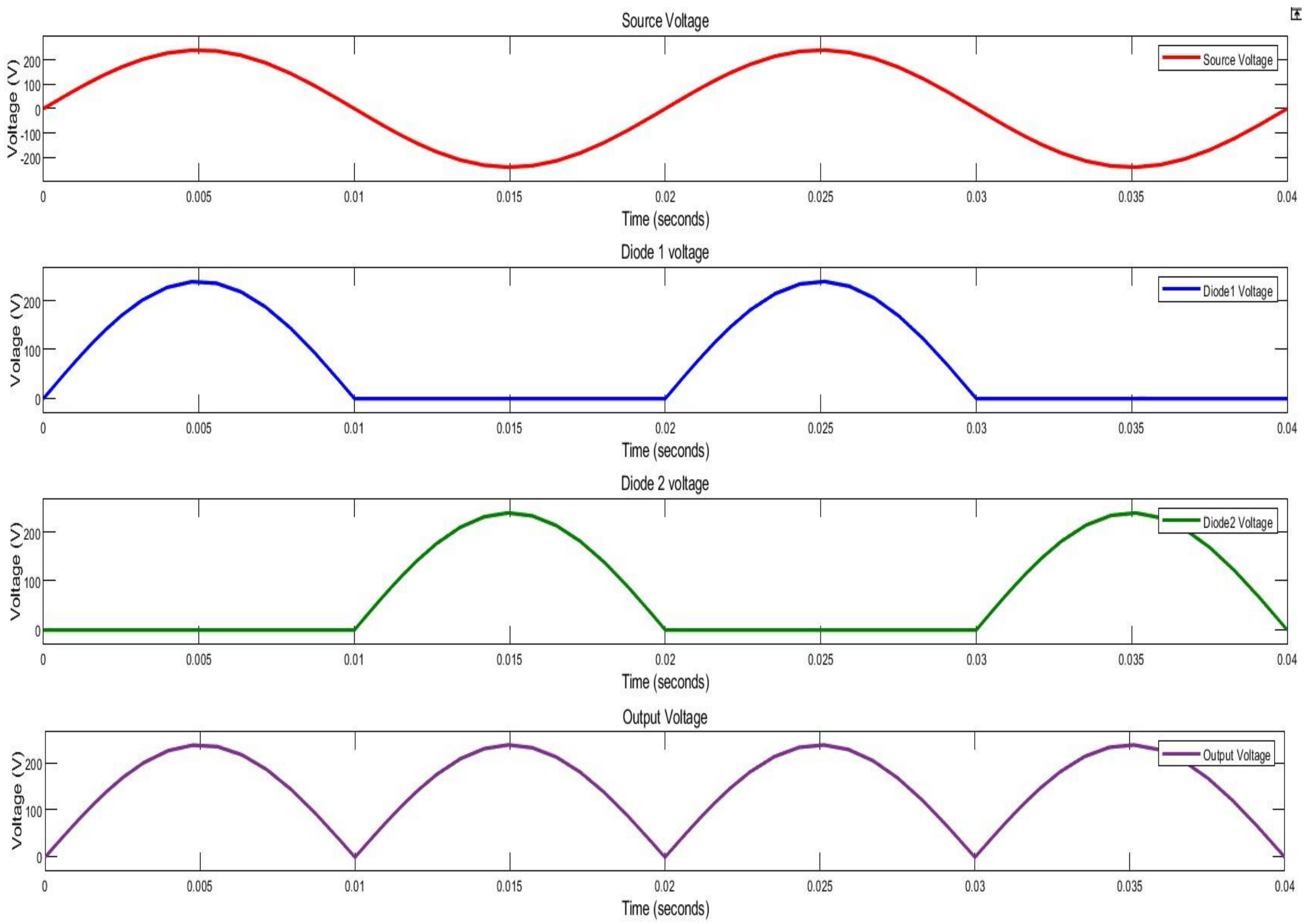


Figure 9.3: MATLAB Simulation diagram of Single Phase Full-wave Bridge Rectifier with RL Load.

Discussion:

In this full-wave bridge rectifier simulation with an RL load, MATLAB Simulink reveals waveforms for the source voltage, diode voltage, and load voltage. The RL load's inductive component extends the conduction period, resulting in a smoother DC output with reduced ripple, compared to rectifiers without inductive loads. The bridge configuration enhances the rectification by maintaining continuous current flow through the load, making this circuit advantageous for applications demanding high-efficiency DC conversion.

Experiment No: 10

Experiment Name: Simulation of Three-Phase Bridge Rectifier with Resistive Load Using MATLAB Simulink.

Apparatus Required:

11. Diode
12. Three-phase programmable voltage source
13. Three-phase V-I measurement
14. Resistor
15. Current measurement
16. Scope

Circuit Diagram:

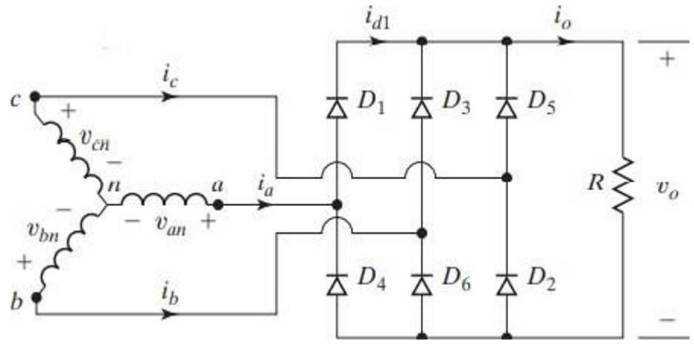


Figure 10.1: Circuit diagram of Three Phase Bridge Rectifier with Resistive Load.

MATLAB Model:

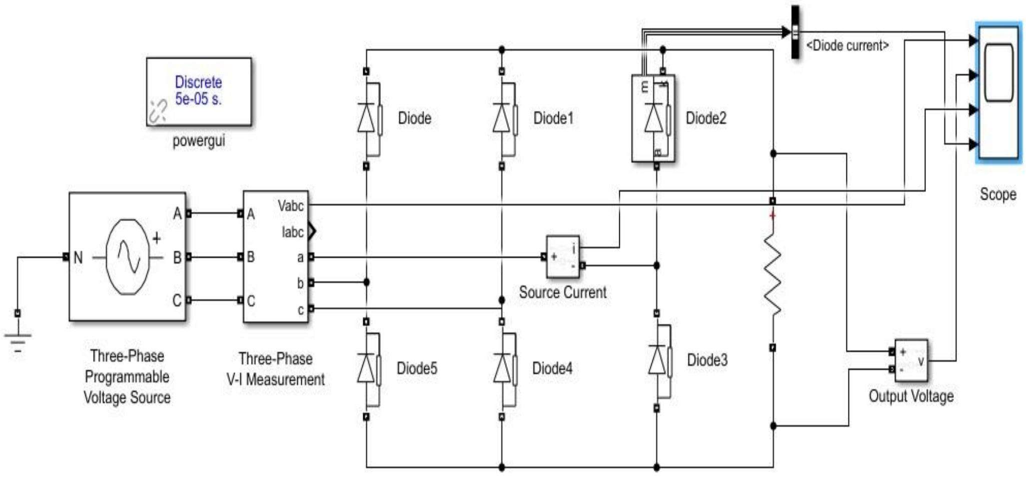


Figure 10.2: MATLAB Circuit Diagram of Three Phase Bridge Rectifier with Resistive Load.

Results:

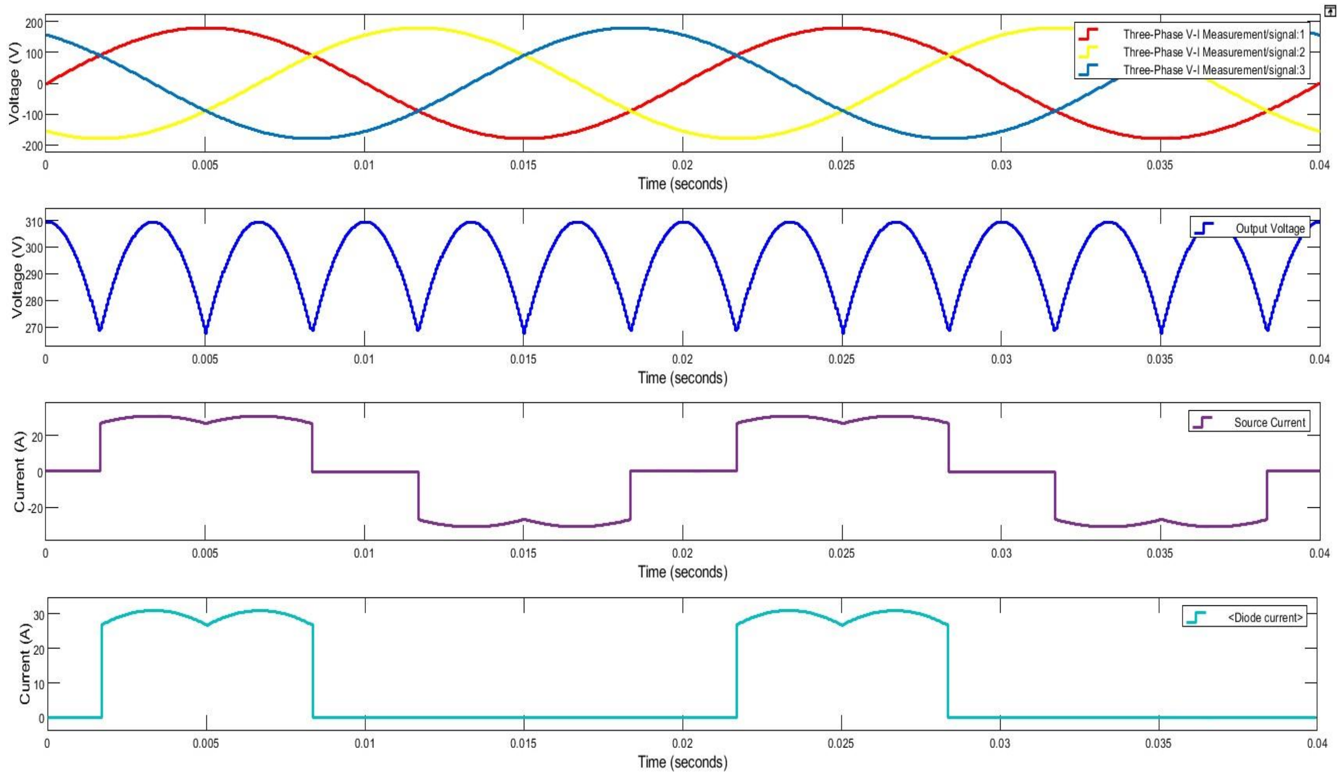


Figure 10.3: MATLAB Simulation diagram of Three Phase Bridge Rectifier with Resistive Load.

Discussion:

The three-phase bridge rectifier simulation with a purely resistive load provides a stable and ripple-free DC output. The graphical results present the three-phase input voltages, the output DC voltage, and the line current. The bridge configuration and the resistive load combine to maintain a steady current flow, converting the AC input into a smooth DC output efficiently. This setup is particularly advantageous in industrial settings where high-power, stable DC output is essential for operational consistency.

Experiment No: 11

Experiment Name: Simulation of Three Phase Bridge Rectifier with RL Load Using MATLAB Simulink.

Apparatus Required:

1. AC voltage source
2. DC voltage source
3. Diode
4. Voltage measurement
5. Resistor
6. Inductor
7. Current measurement
8. Scope

Circuit Diagram:

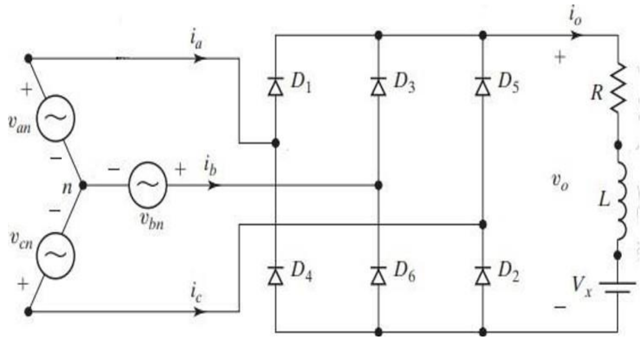


Figure 11.1: Circuit diagram of Three Phase Bridge Rectifier with RL Load.

MATLAB Model:

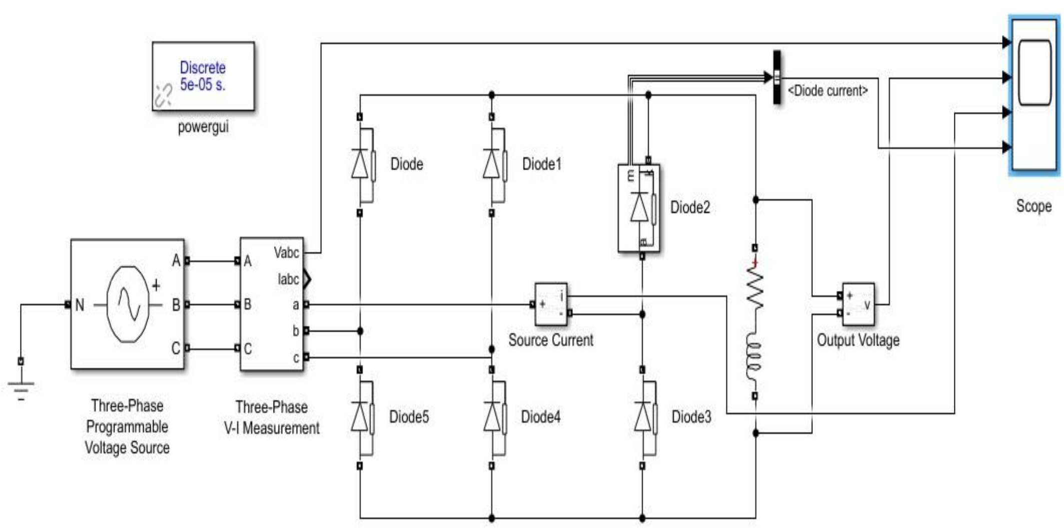


Figure 11.2: MATLAB Circuit diagram of Three Phase Bridge Rectifier with RL Load.

Results:

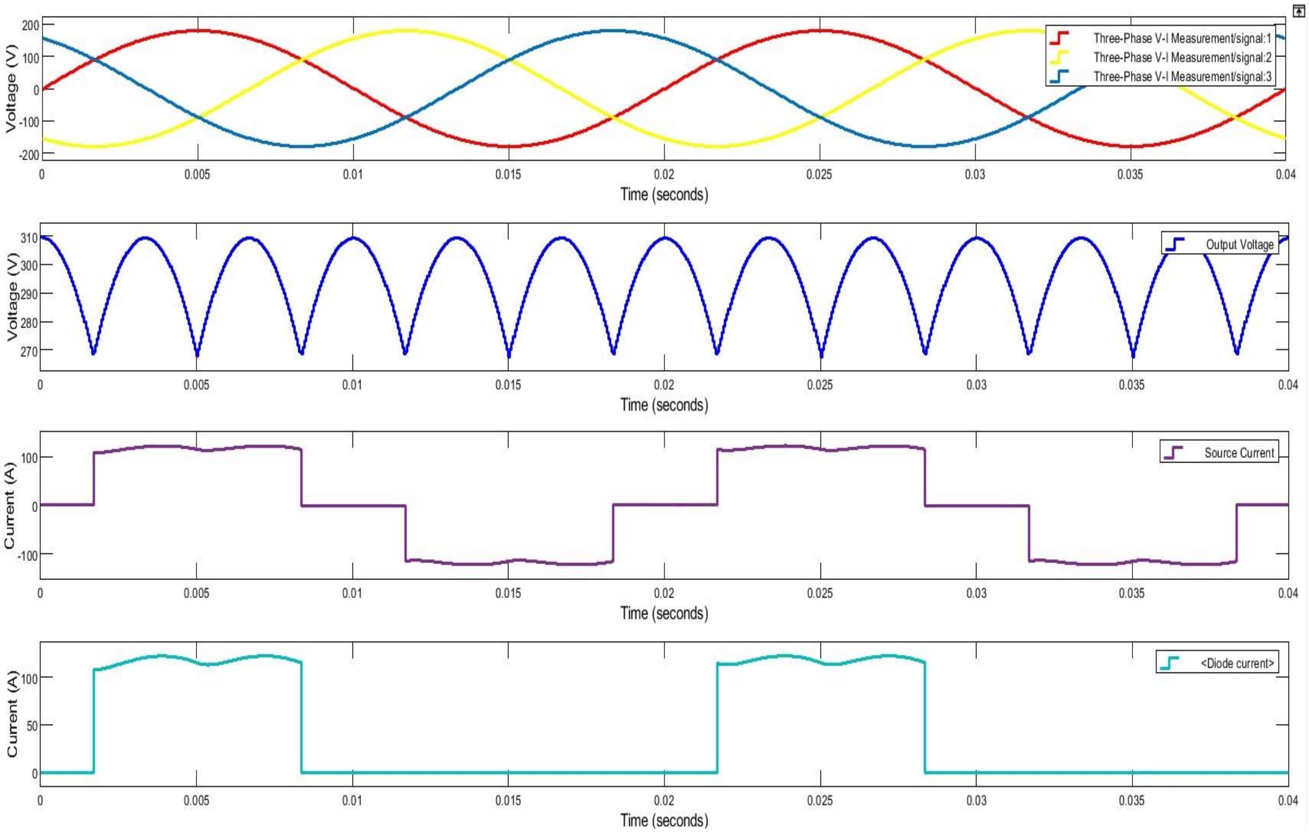


Figure 11.3: MATLAB Simulation diagram of Three Phase Bridge Rectifier with RL Load

Discussion:

This simulation of a three-phase bridge rectifier with an RL load demonstrates the behavior of a rectifier with both resistive and inductive components. The three-phase AC input is efficiently converted to a steady DC output, with the inductor ensuring smoother current transitions and reducing ripple in the output waveform. The inclusion of an inductive load stabilizes the line current and output voltage, making the circuit highly suitable for applications that require reliable DC power with minimal fluctuation, commonly seen in industrial machinery and high-demand electrical systems.

Experiment No: 12

Experiment Name: Simulation of Single phase Half Bridge Inverter Using MATLAB Simulink.

Apparatus Required:

16. DC voltage source
17. IGBT/Diode
18. Pulse generator
19. Resistor
20. Capacitor
21. Voltage measurement
22. Current measurement
23. Scope

Circuit diagram:

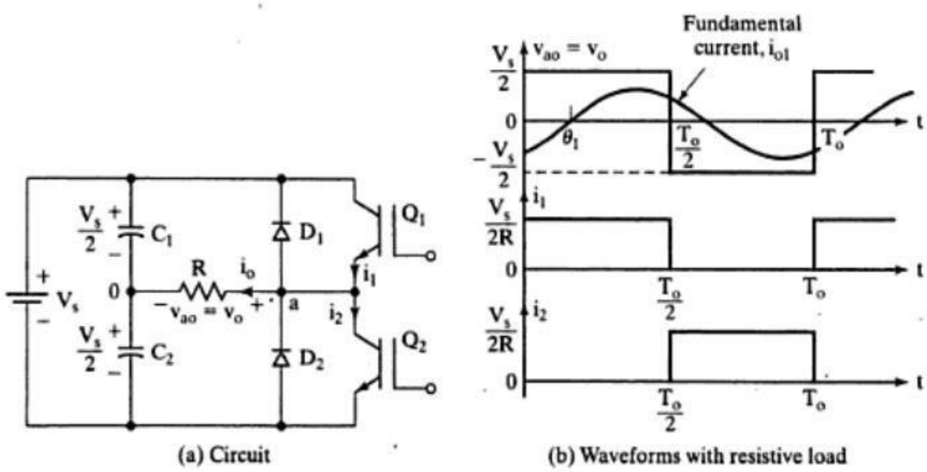


Figure 12.1: Circuit diagram of Single phase Half Bridge Inverter.

MATLAB Model:

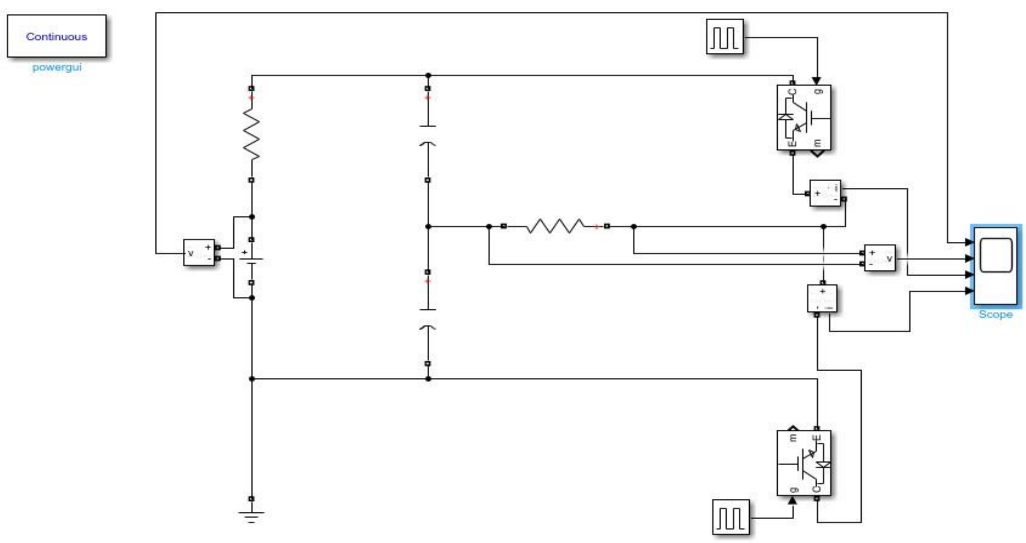


Figure 12.2: MATLAB circuit diagram of Single phase Half Bridge Inverter.

Results:

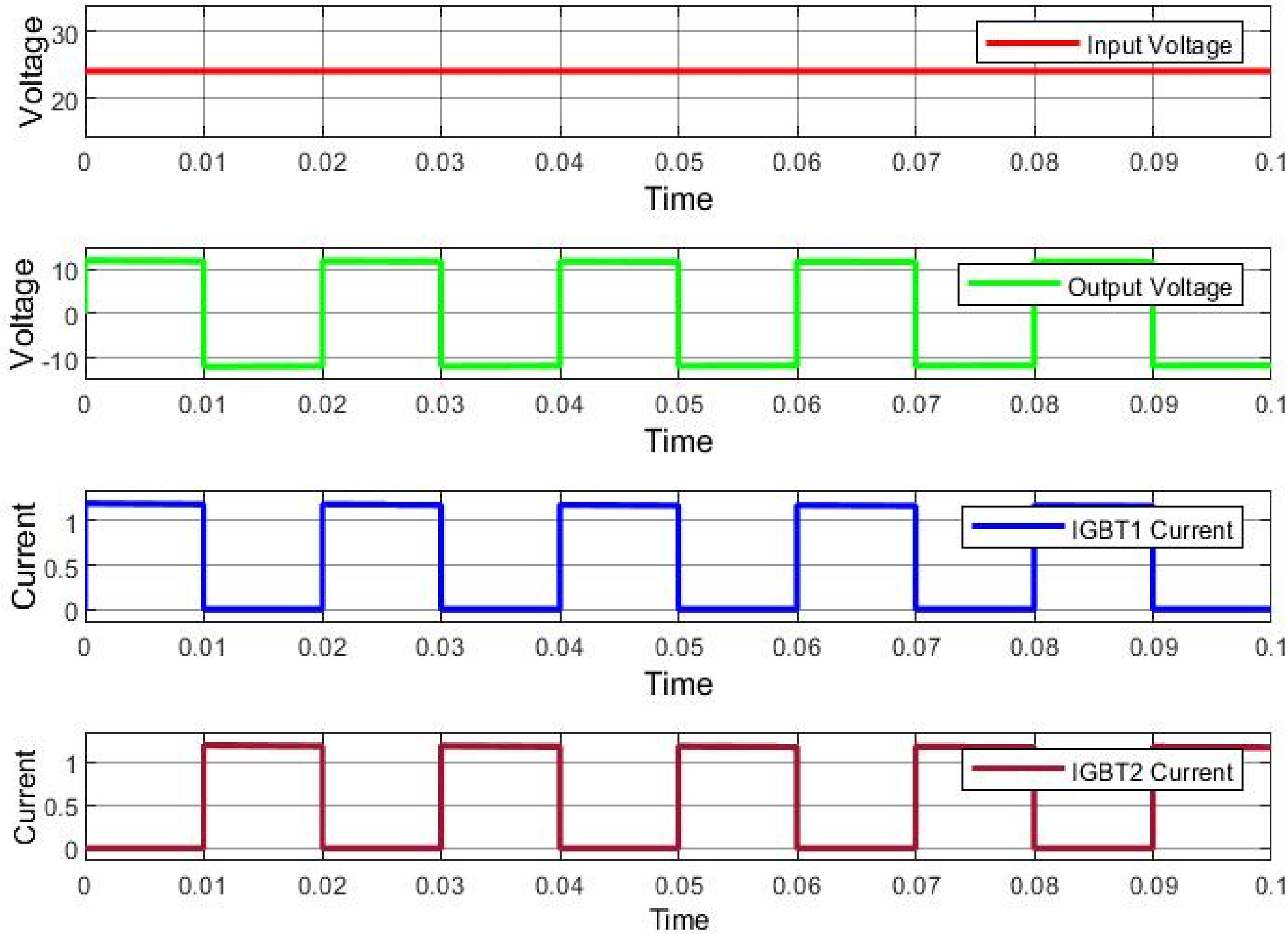


Figure 12.3: MATLAB Simulation Signal diagram of Single phase Half Bridge Inverter.

Discussion:

In this experiment, a single-phase half-bridge inverter was simulated to convert DC voltage into an AC output. The simulation demonstrated the alternating operation of two IGBTs, which generated a square wave AC voltage by switching the positive and negative terminals of the DC source across the load. The results showed a symmetrical output waveform, verifying the correct implementation of the circuit. This experiment highlighted the importance of precise pulse timing to ensure efficient inverter operation, making it suitable for low-power AC applications.

Experiment No: 13

Experiment Name: Simulation of Single phase Full Bridge Inverter Using MATLAB Simulink.

Apparatus Required:

16. DC voltage source
17. IGBT/Diode
18. Pulse generator
19. Logical operator
20. Resistor
21. Capacitor
22. Voltage measurement
23. Scope

Circuit Diagram:

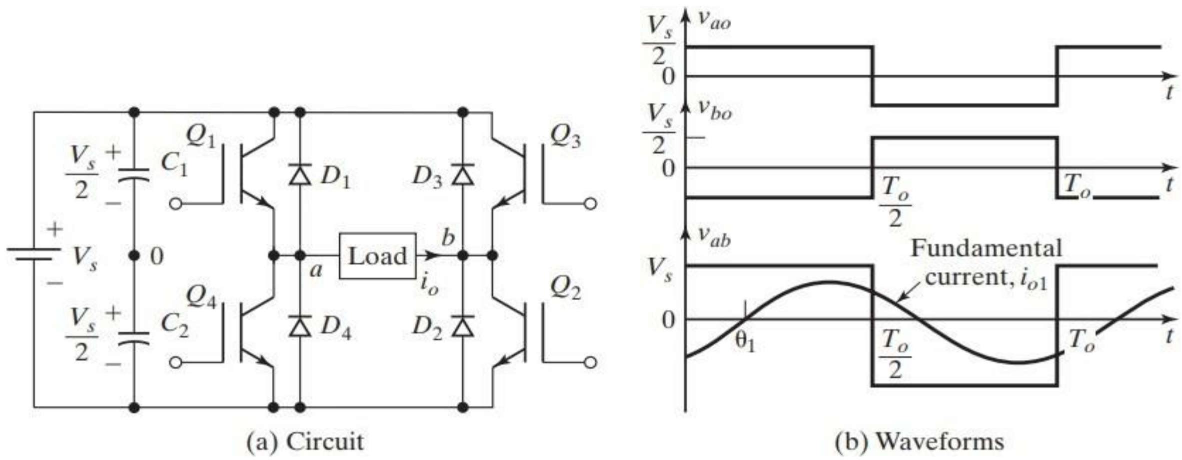


Figure 13.1: Circuit diagram of Single-Phase Full Bridge Inverter.

MATLAB Model:

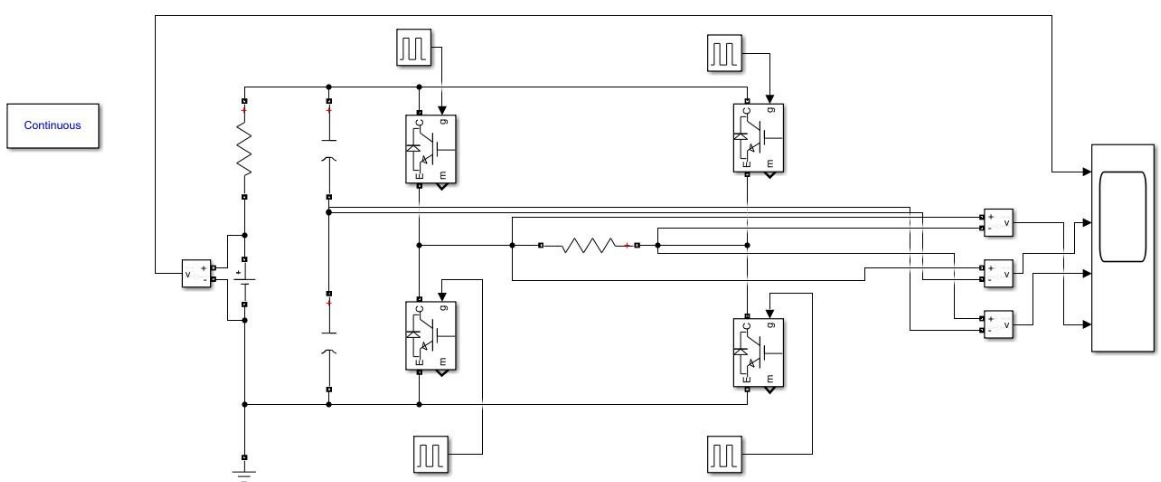


Figure 13.2: MATLAB diagram of Single-Phase Full Bridge Inverter.

Results:

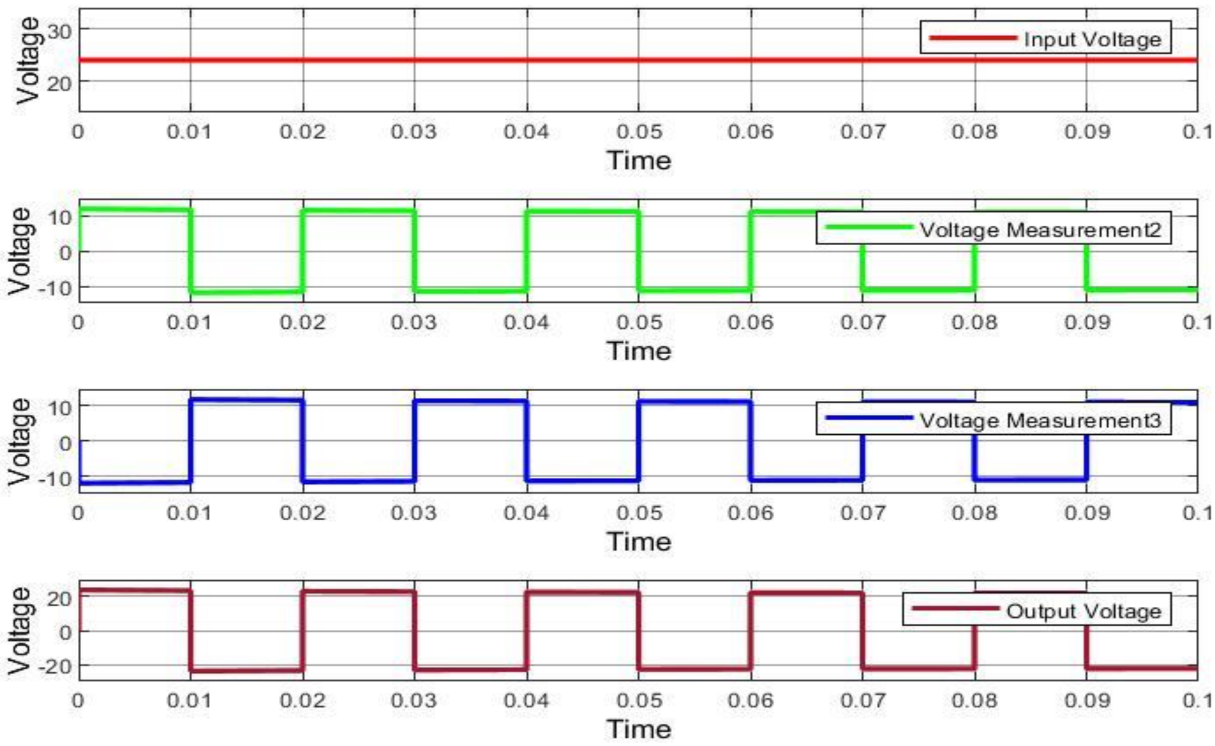


Figure 13.3: MATLAB Simulation Signal Phase Full Bridge Inverter.

Discussion:

Simulation of a single-phase full-bridge inverter was conducted to produce a complete AC waveform from a DC source. Four IGBT switches operated in pairs to alternate the polarity of the DC voltage, resulting in an output that switches between +Vs and -Vs. The observed waveform matched theoretical expectations, demonstrating the full-bridge inverter's capability to deliver higher voltage levels than the half-bridge configuration. This experiment underscores the inverter's efficiency and its relevance in applications requiring a full AC waveform, such as motor drives and renewable energy systems.

Experiment No: 14

Experiment Name: Simulation of Buck Converter using MATLAB Simulink.

Apparatus Required:

17. DC voltage source
18. Resistor
19. IGBT
20. Pulse generator
21. Inductor
22. Capacitor
23. Diode
24. Current measurement
25. Display
26. Voltage measurement
27. Scope

Circuit Diagram:

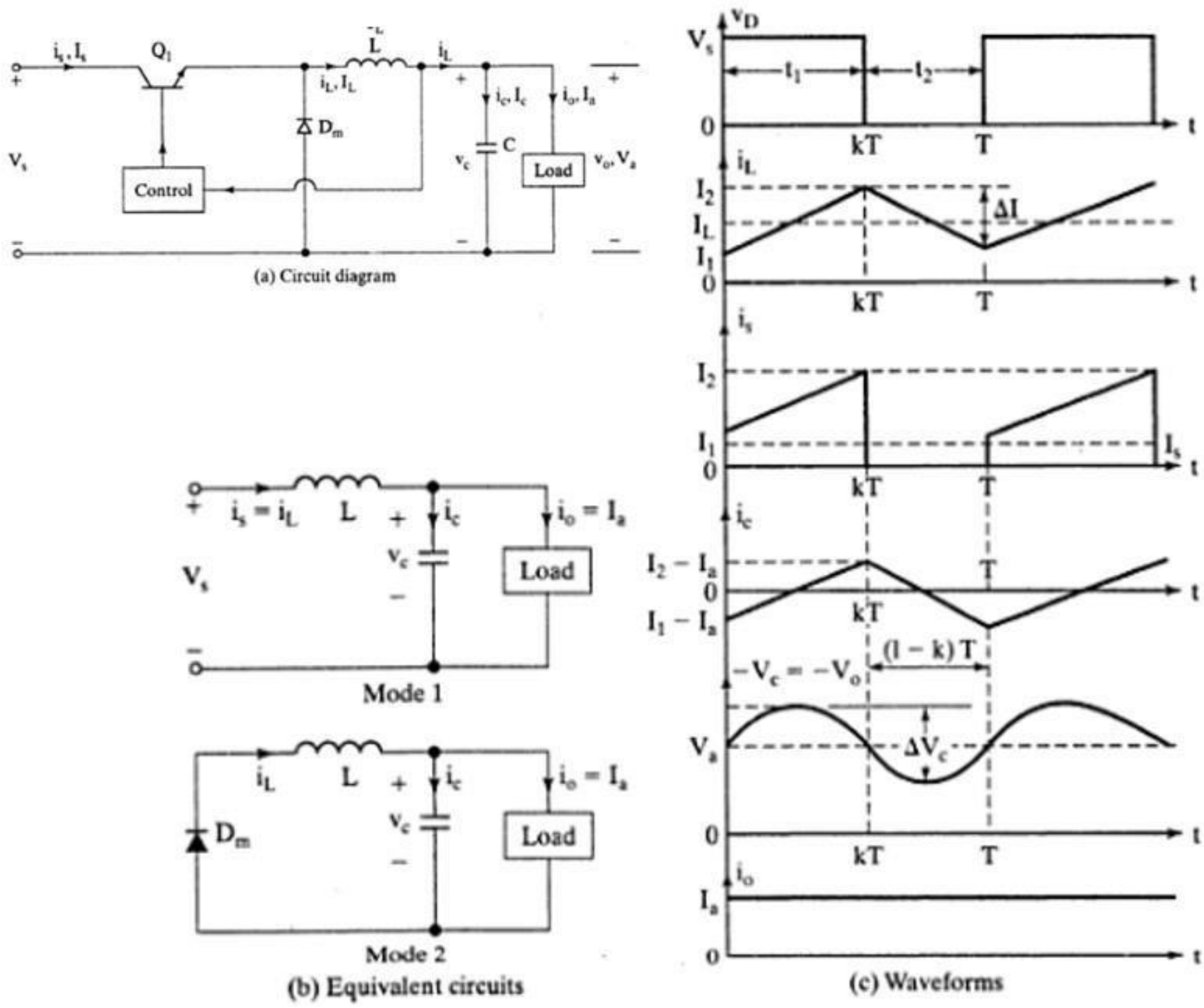


Figure 14.1: Circuit diagram of Buck Converter.

MATLAB Model:

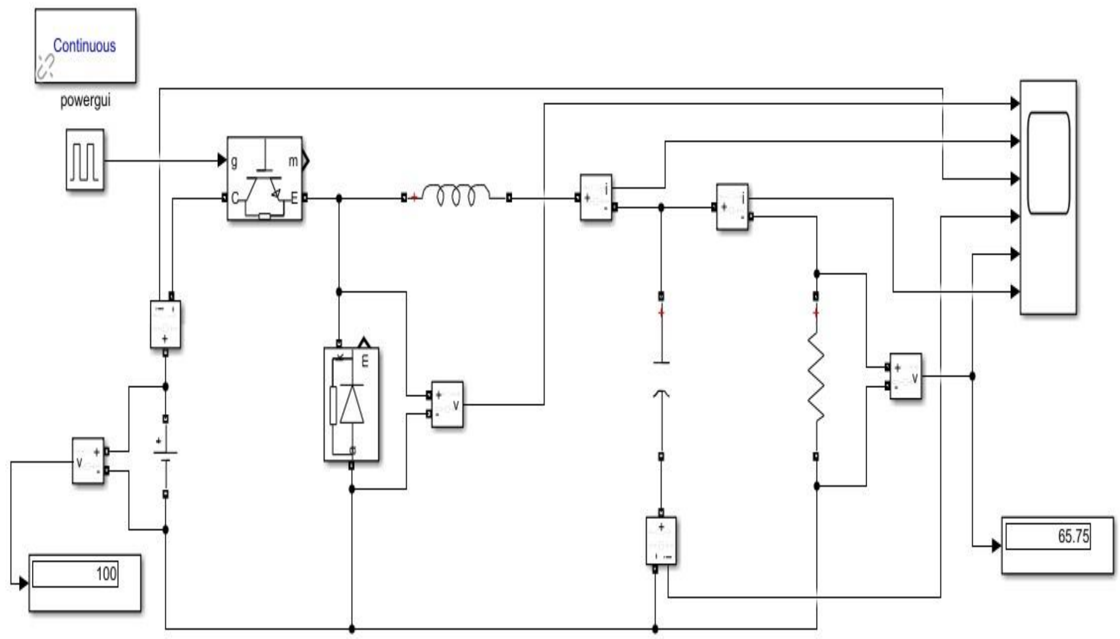


Figure 14.2: MATLAB diagram of Buck Converter.

Results:

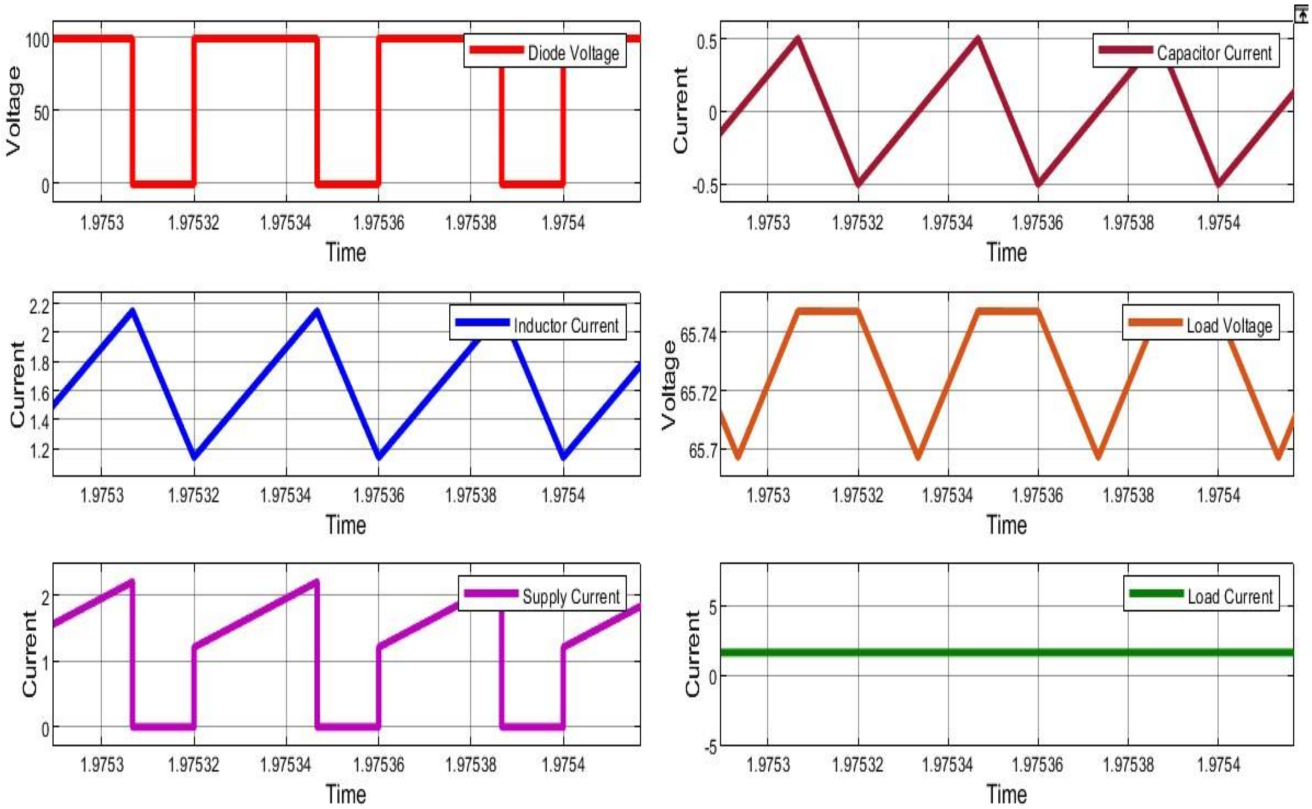


Figure 14.3: MATLAB Simulation diagram of Buck Converter.

Discussion:

This experiment involved simulating a buck converter to reduce DC input voltage to a lower, stable DC output. The simulation produced expected waveforms for diode voltage, inductor current, and output voltage, all of which validated the converter's operation. The results showed smooth voltage regulation with high efficiency, confirming the buck converter's effectiveness for power supply applications. Its simplicity and performance make it a preferred choice for voltage regulation in electronic systems.

Experiment No: 15

Experiment Name: Simulation of Boost Converter using MATLAB Simulink.

Apparatus Required:

15. DC voltage source
16. MOSFET
17. Pulse Generator
18. Diode
19. Resistor
20. Inductor
21. Capacitor
22. Voltage measurement
23. Current measurement
24. Scope
25. Display

Circuit Diagram:

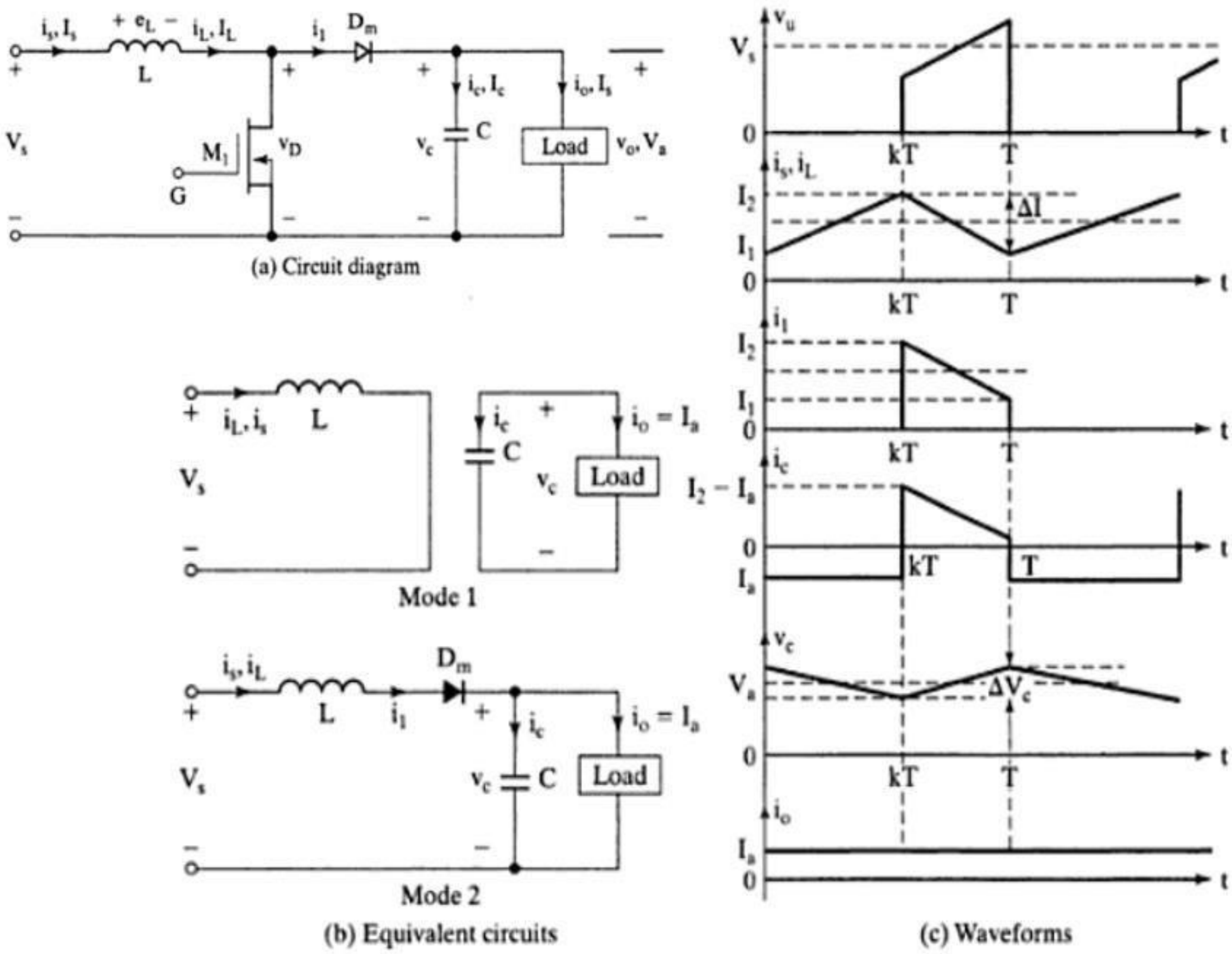


Figure 15.1: Circuit diagram of Boost Converter.

MATLAB Model:

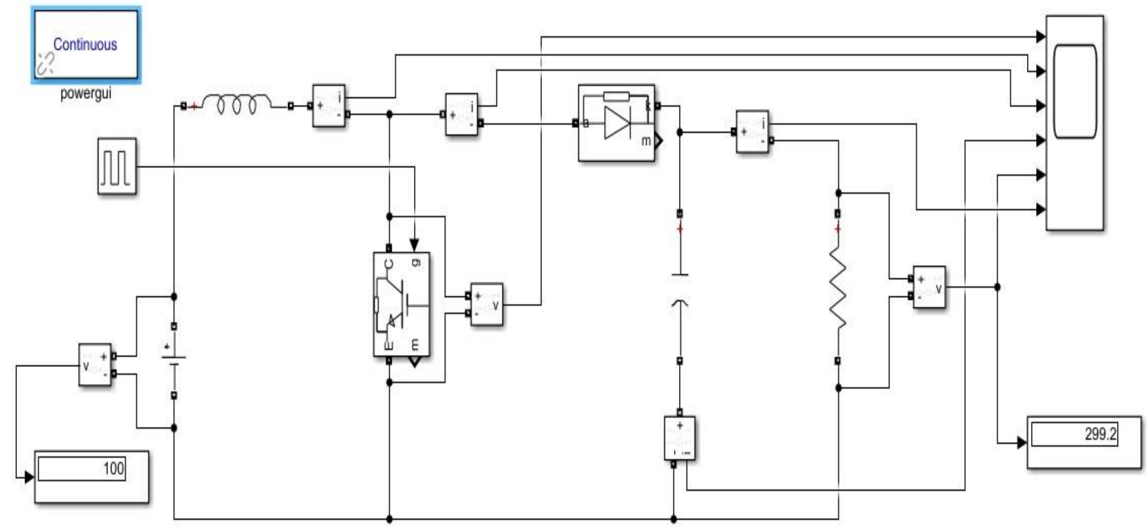


Figure 15.2: MATLAB Circuit diagram of Boost Converter.

Results:

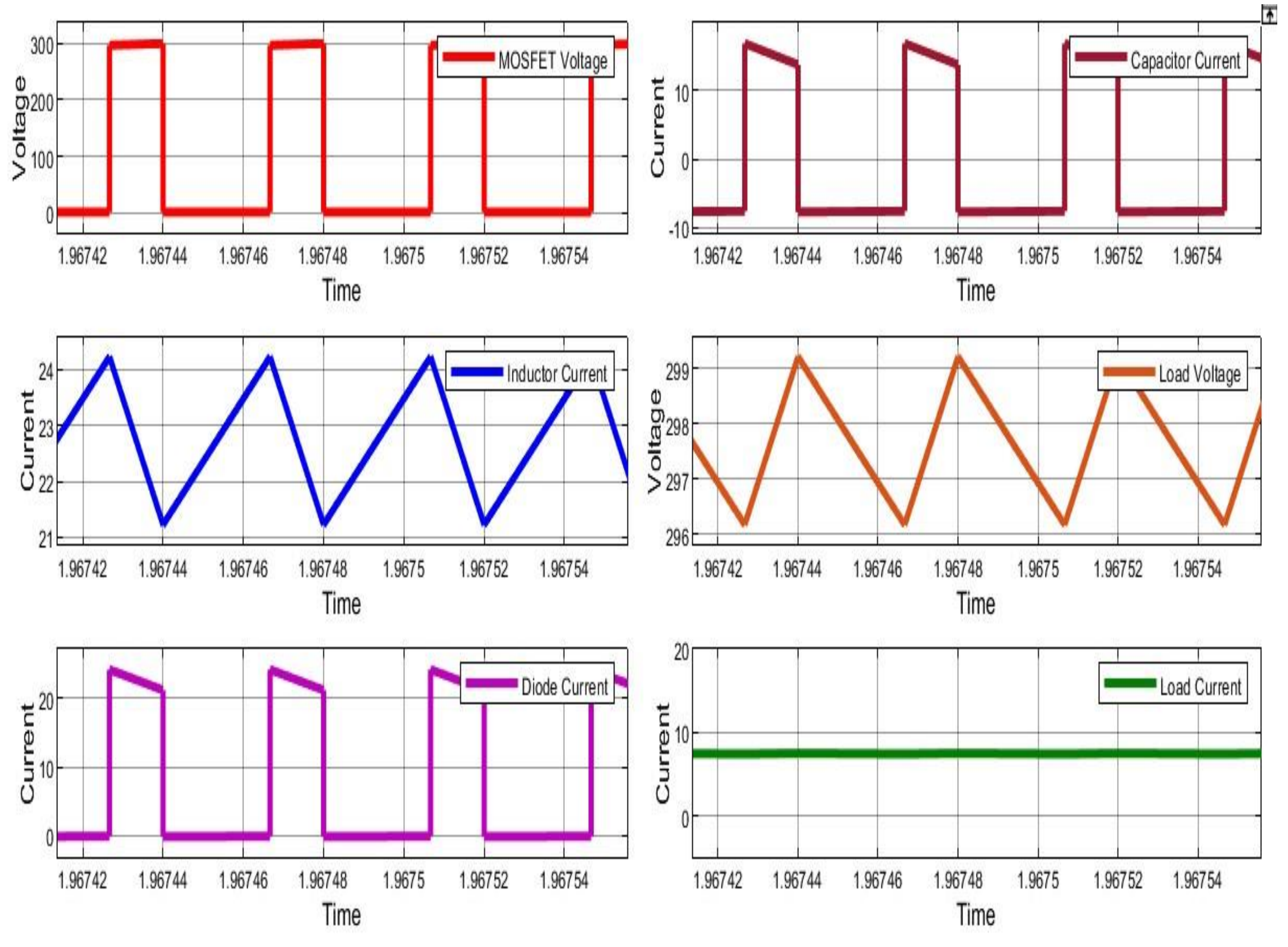


Figure 15.3: MATLAB Simulation diagram of Boost Converter.

Discussion:

The boost converter simulation successfully increased the input DC voltage to a higher output voltage. The results included smooth and consistent waveforms for inductor current, diode current, and output voltage, reflecting the converter's high efficiency. This experiment validated the ability of the boost converter to step up voltage without the need for a transformer. The findings confirm its suitability for applications like renewable energy systems and portable electronic devices, where voltage enhancement is often required.

Experiment No: 16

Experiment Name: Simulation of Buck-Boost Converter using MATLAB Simulink.

Apparatus Required:

17. DC voltage source
18. IGBT
19. Pulse generator
20. Diode
21. Inductor
22. Resistor
23. Capacitor
24. Voltage measurement
25. Current measurement
26. Scope
27. Display

Circuit Diagram:

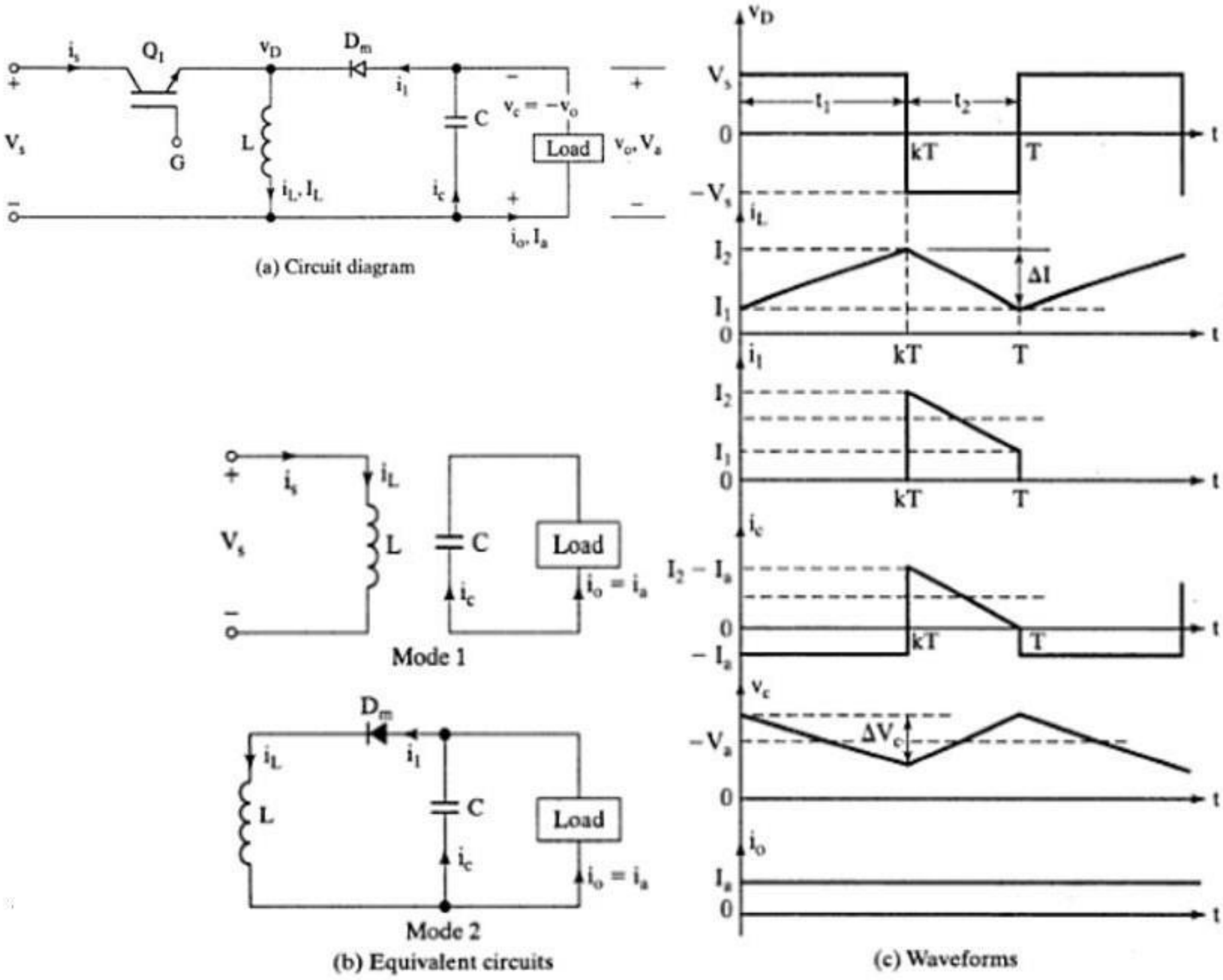


Figure 16.1: Circuit diagram of Buck-Boost Converter.

MATLAB Model:

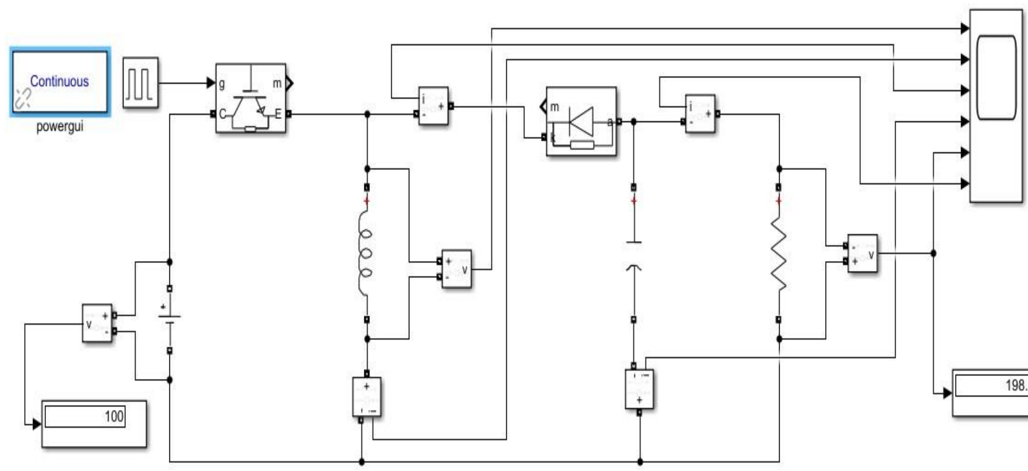


Figure 16.2: MATLAB Circuit diagram of Buck-Boost Converter.

Results:

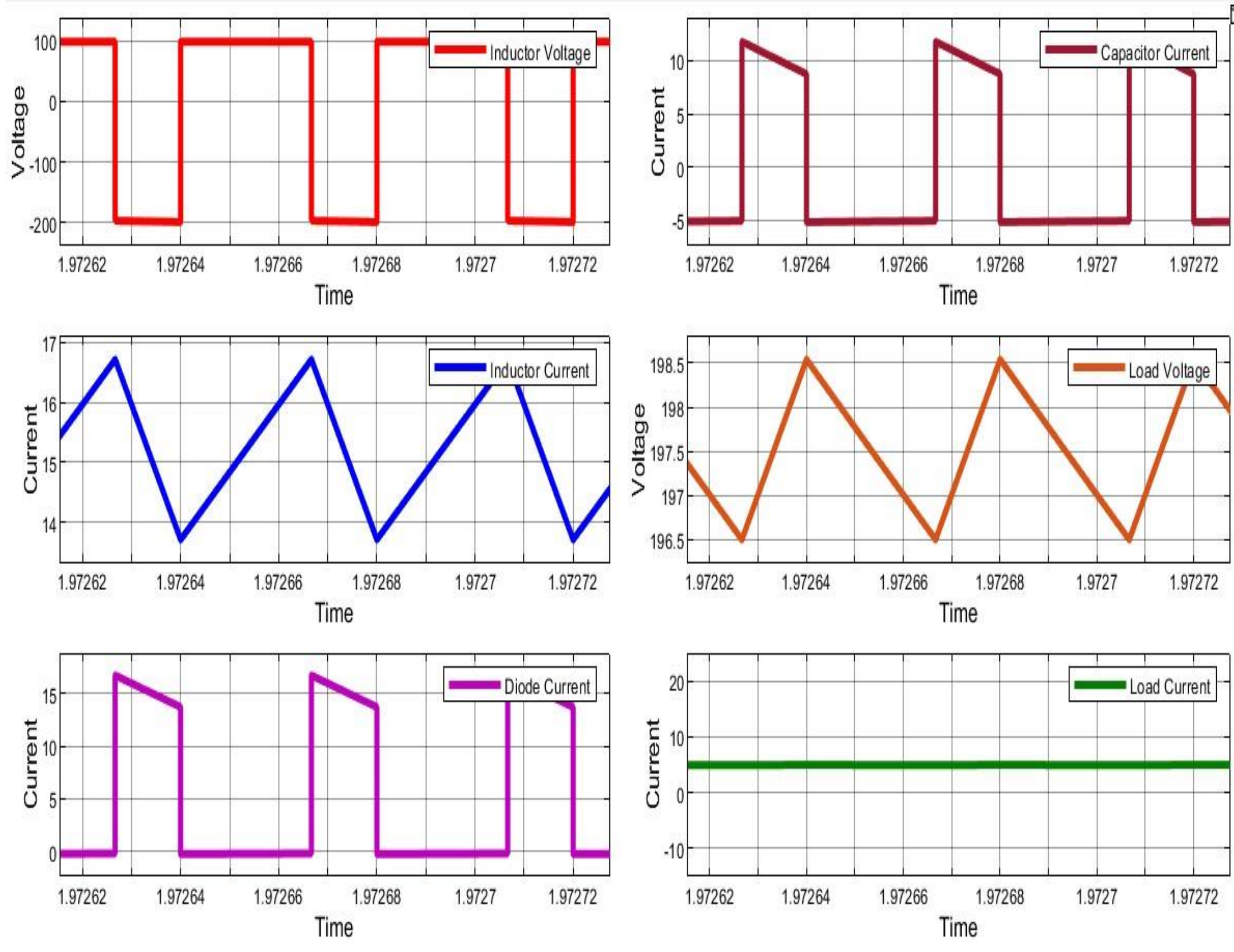


Figure 16.3: MATLAB Simulation diagram of Buck-Boost Converter.

Discussion:

The simulation of the buck-boost converter demonstrated its dual capability to step up or step down voltage, as well as reverse the polarity of the output voltage. The waveforms observed during the simulation confirmed the converter's efficient performance and adaptability to varying input voltages. The results align with theoretical predictions, showcasing its versatility in power supply applications. This experiment highlights the buck-boost converter as a reliable option for systems requiring flexible voltage regulation.

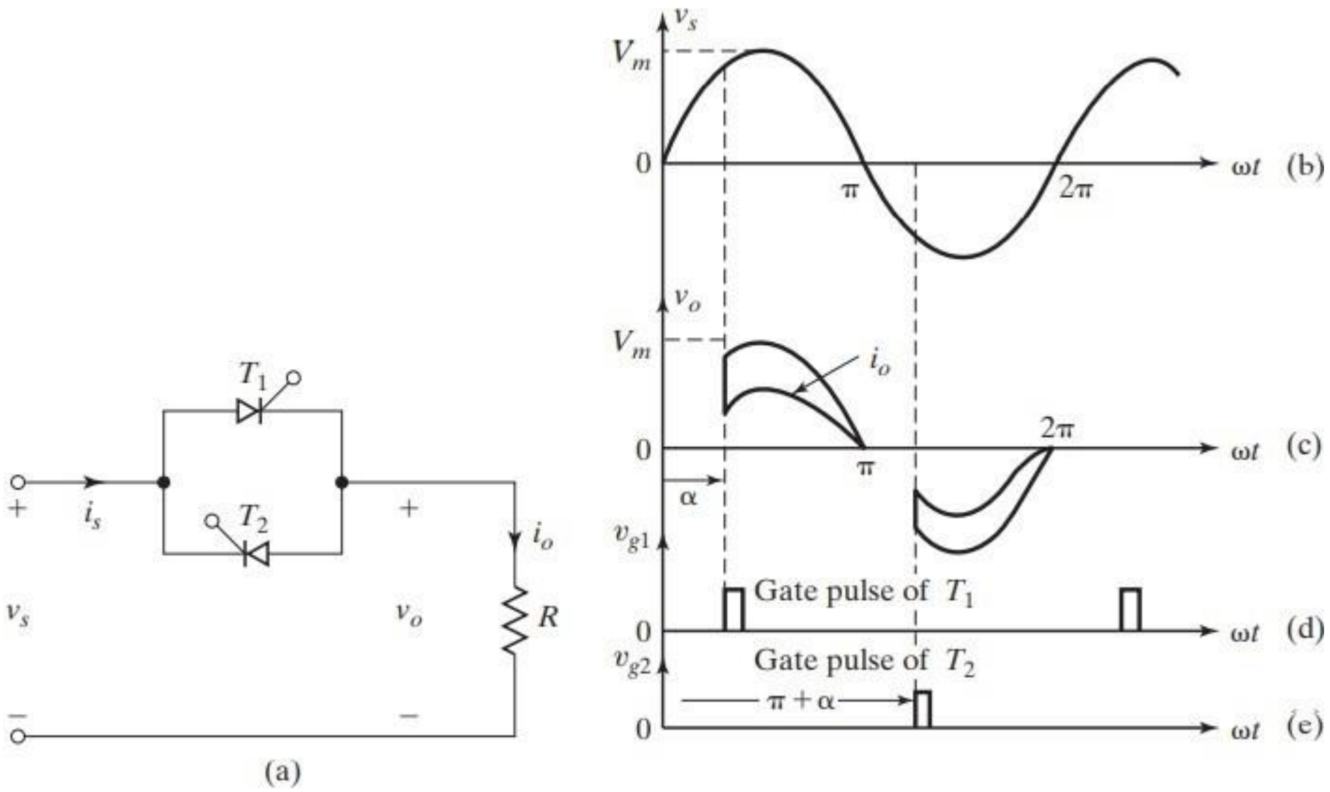
Experiment No: 17

Experiment Name: Simulation of Single phase full wave AC voltage controller with resistive load using MATLAB Simulink.

Apparatus Required:

1. AC voltage source
2. Thyristor
3. Pulse generator
4. Resistor
5. Voltage measurement
6. Current measurement
7. Mux
8. Scope

Circuit Diagram:



Single-phase full-wave controller. (a) Circuit, (b) Input supply voltage, (c) Output voltage, (d) Gate pulse for T_1, and (e) Gate pulse for T_2.

Figure 17.1: Circuit diagram of Single-phase full-wave controller.

MATLAB Model:

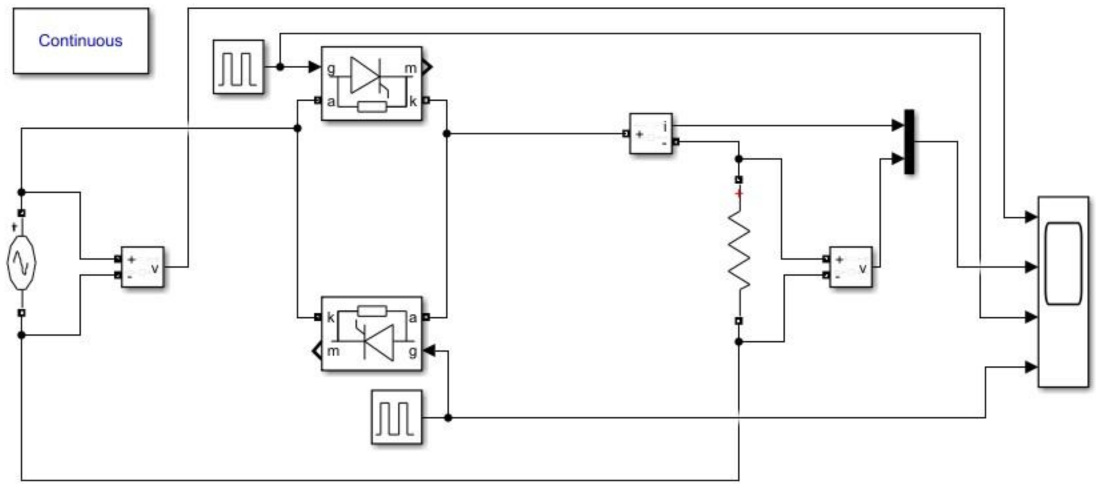


Figure 17.2: MATLAB Circuit diagram of Single-phase full-wave controller.

Results:

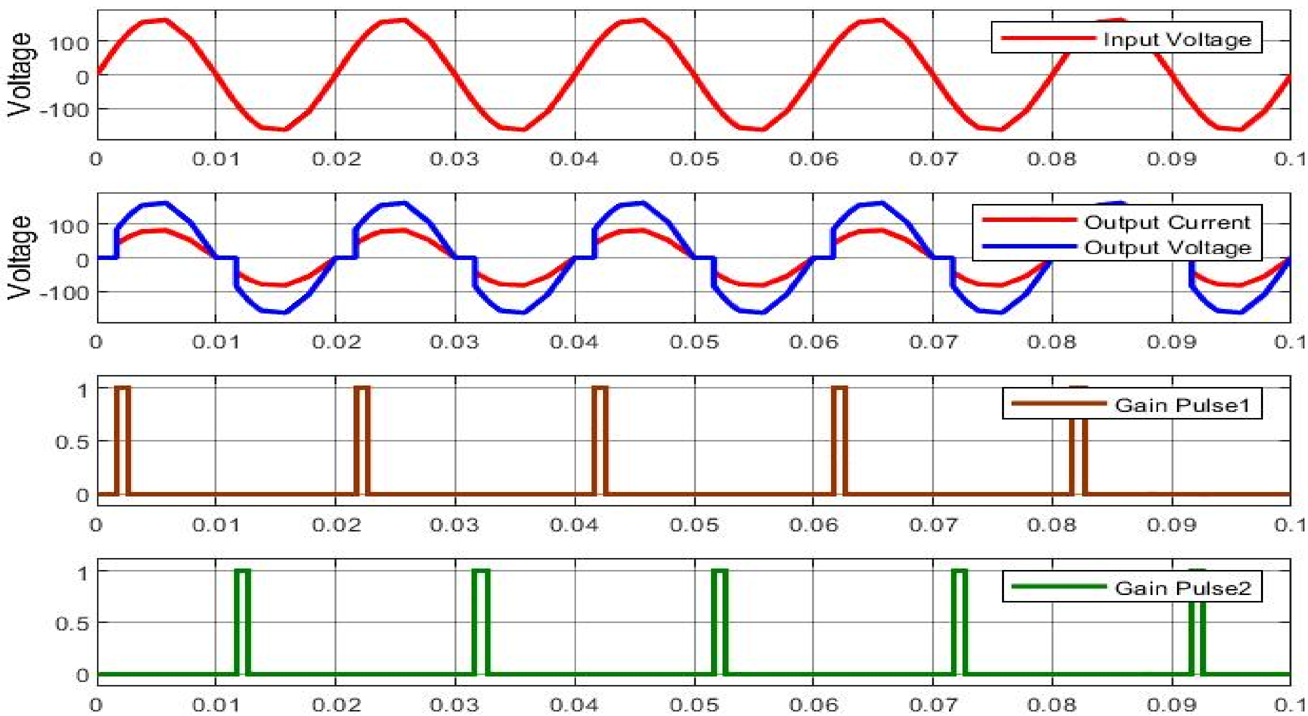


Figure 17.3: MATLAB Simulation diagram of Single-phase full-wave controller.

Discussion:

This experiment involved simulating a single-phase full-wave AC voltage controller with a resistive load using MATLAB Simulink. The simulation showcased how the firing angles of thyristors, set at 30 degrees and 210 degrees, regulated the RMS voltage across the load by modulating the input and output voltages. The results validated that precise adjustment of firing angles enables efficient control of power delivery to the resistive load. This approach demonstrates the controller's effectiveness in voltage regulation for various practical applications.