SIMULATION OF UNCONTROLLED RECTIFIER ON MATLAB / SIMULINK

Objective: The objective of this experiment is to study the operation of single-phase uncontrolled rectifiers using MATLAB/SIMULINK.

Parameter:

Parameter	Value
Input voltage	230 V, 50 Hz
Source Inductance	10 mH
Case 1: Load	20 Ω
Case 2: Load	20 Ω in series with 20 mH Inductance
Case 3: Load	20 Ω in series with 200 mH Inductance
Case 4: Load with Source Inductance	20 Ω in series with 200 mH inductance & L_s =10mH

Theory: Rectifier is a AC to DC converter. In this converter we are using diode so we do not have controlled output so it is an uncontrolled rectifier.

Avg. Output Voltage:

$$V_o = \frac{2V_m}{\pi}$$

Where V_m is maximum input voltage.

Overlap angle μ (when source inductance present):

$$\cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_s I_o}{V_m}$$

Design procedure and final design parameters obtained:

- In positive half cycle of input voltage D_1 and D_2 conducts, so

$$V_o = V_{in}$$

- In negative half cycle of input voltage D_3 and D_4 conducts, so

$$V_o = -V_{in}$$

- Here we are taking 100 Samples for each Time period So, Sampling frequency is 100 times of maximum frequency(100Hz).
  So, Sampling Time Period = 100μSec.

Circuit Diagram and Theoratical Waveforms:

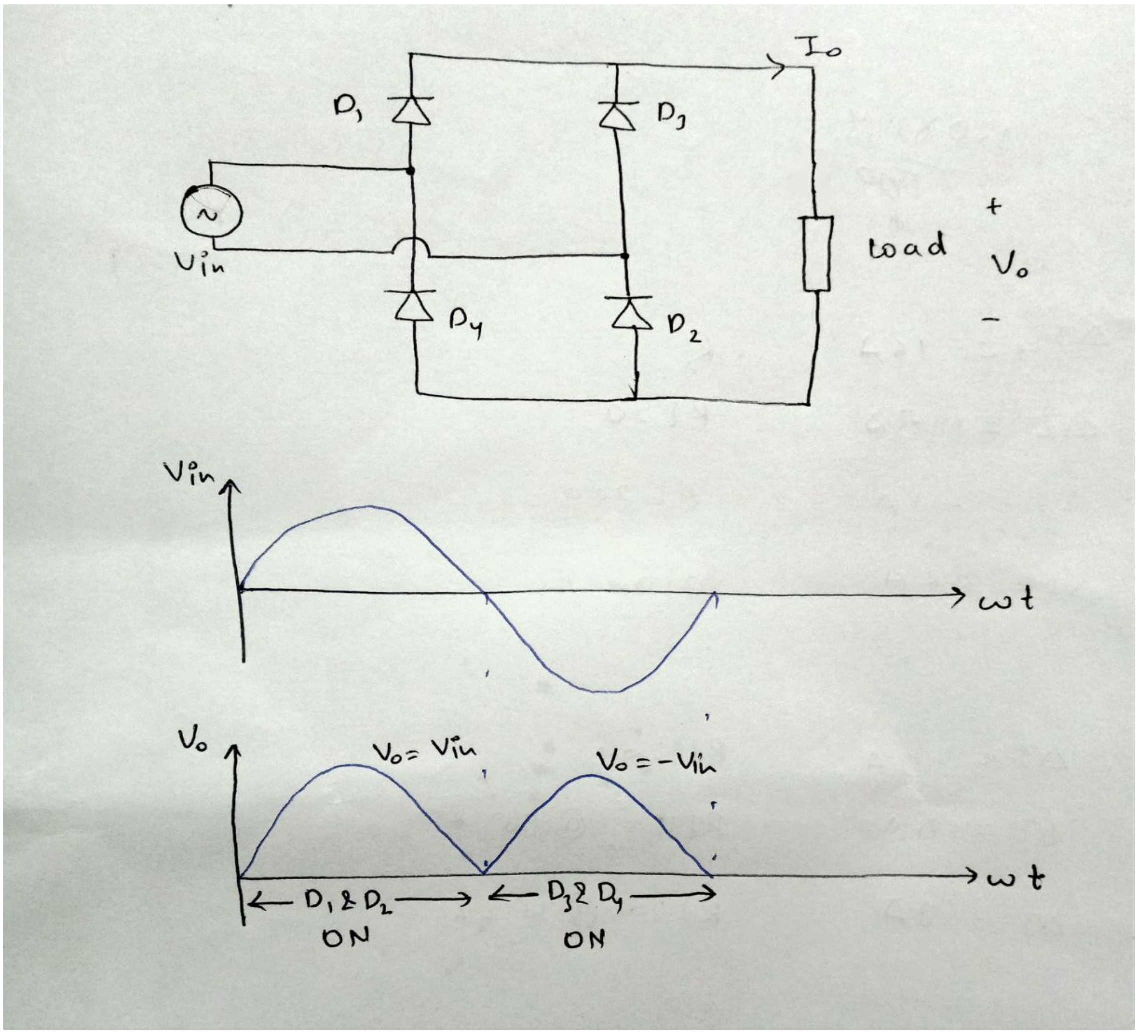


Fig.1 Theoratical Diagram of Uncontrolled Rectifier

Simulation Model:

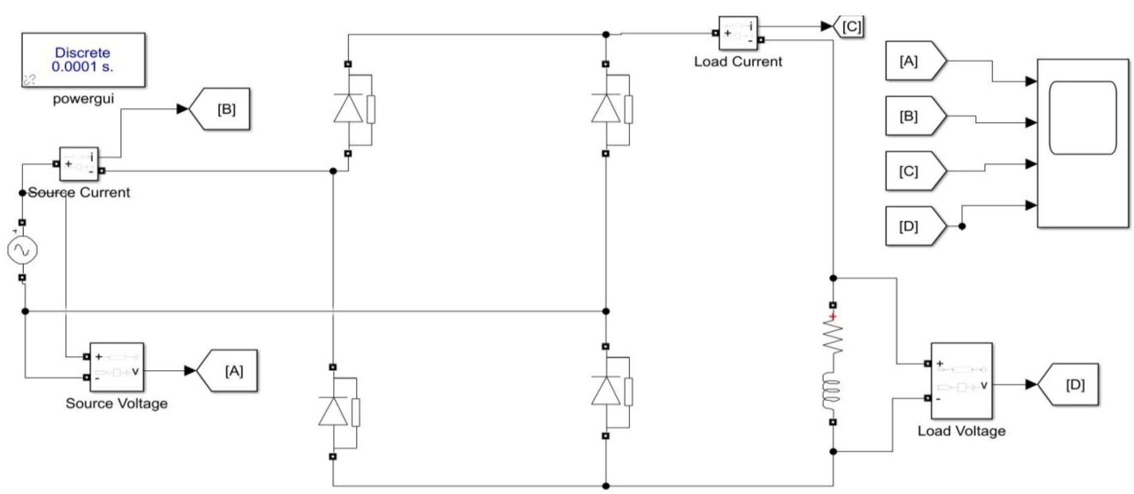


Fig.2 Simulation model without source inductance

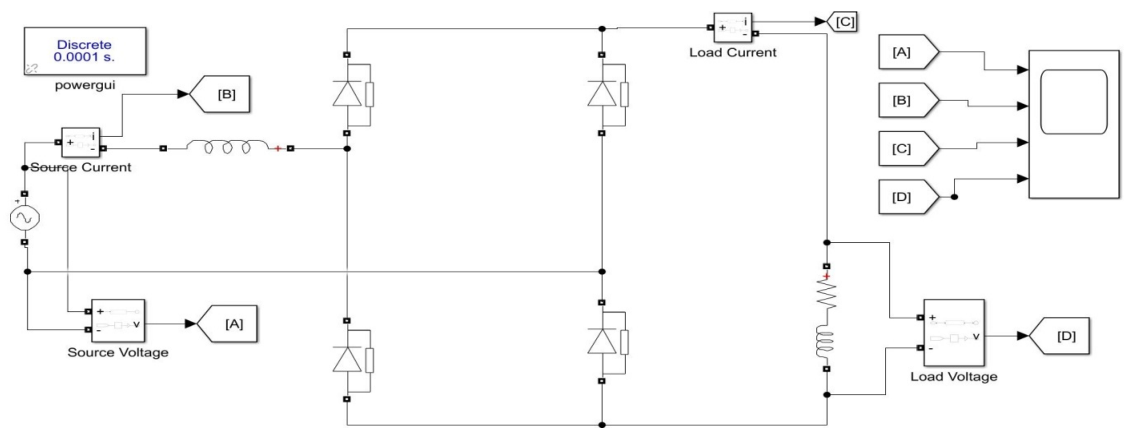
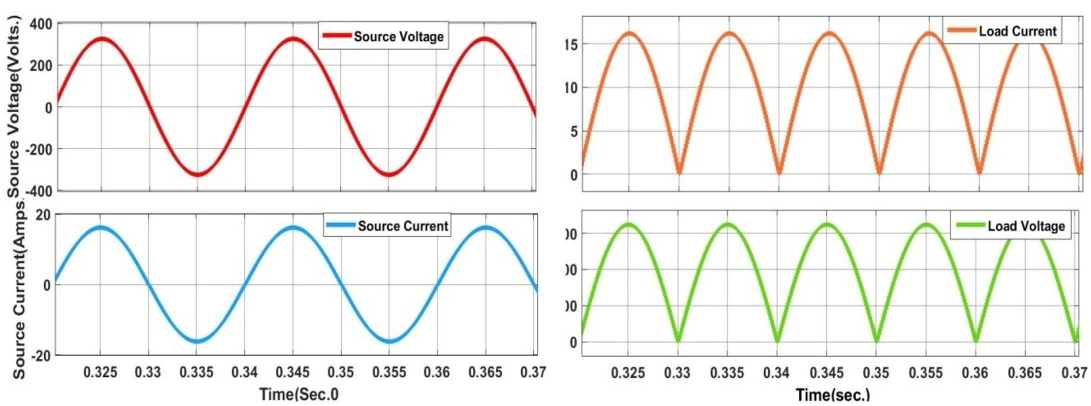


Fig.3 Simulation model with source inductance

Waveforms and Results:

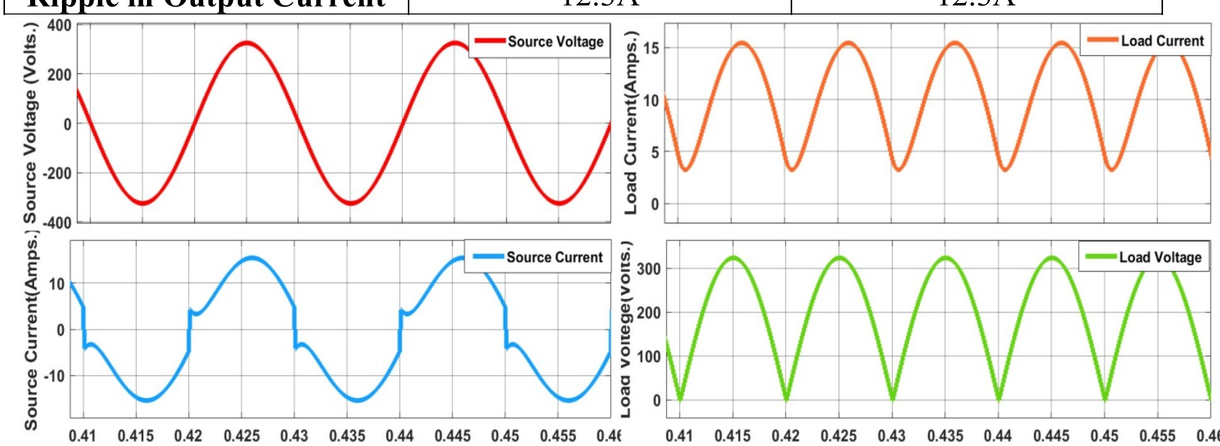
Case 1 : Load 1 (R=20Ω)

	Theoratical	Practical
Avg. Output Voltage	207V	206V
Ripple in Output Current	16.25A	16A



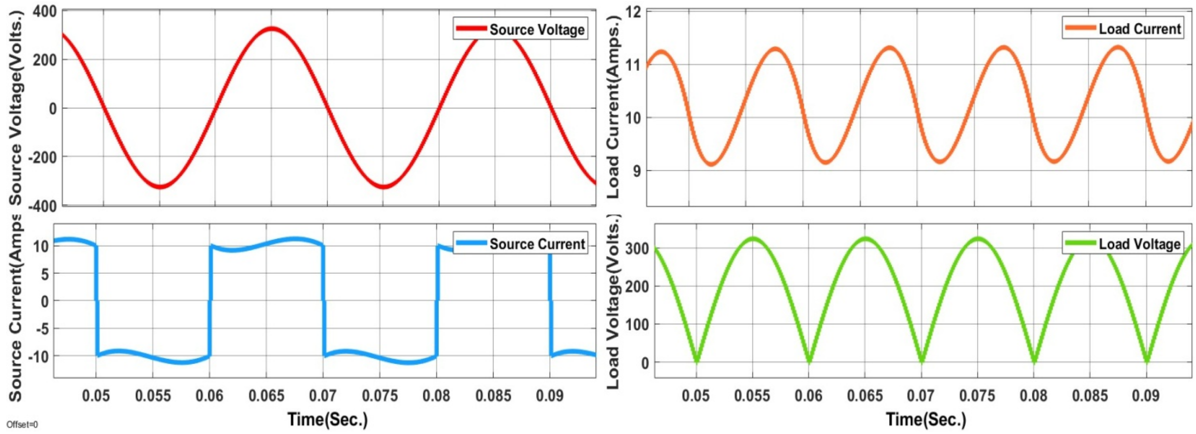
Case 2 : Load 2 (R=20Ω & L=20mH)

	Theoratical	Practical
Avg. Output Voltage	207V	206V
Ripple in Output Current	12.3A	12.3A



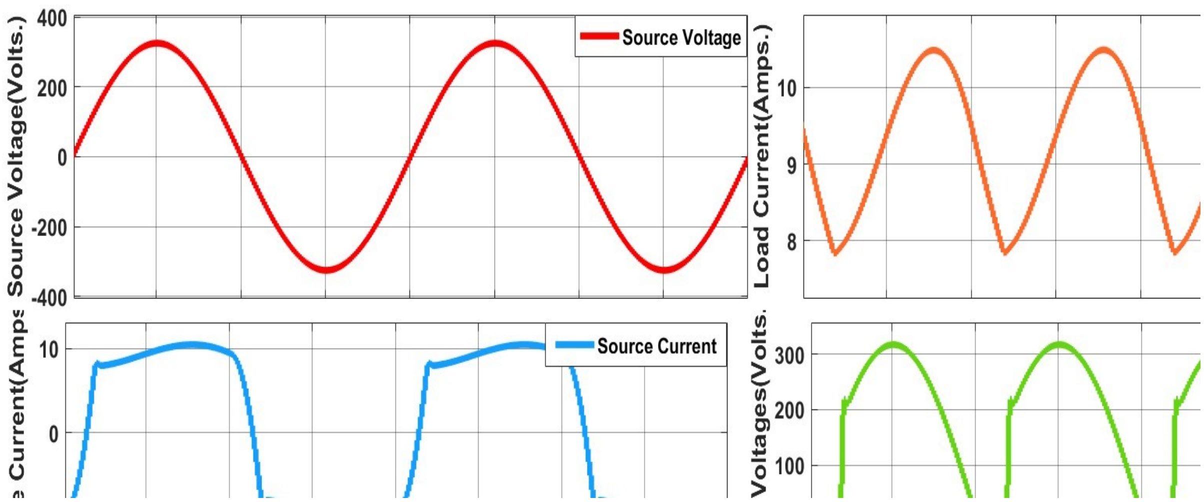
Case 3 : Load 3 (R=20Ω & L=200mH)

	Theoratical	Practical
Avg. Output Voltage	207V	206V
Ripple in Output Current	3.1A	3.8A



Case 4 : Load 3 (R=20Ω & L=20mH) with Source Inductance (L_m)

	Theoratical	Practical
Avg. Output Voltage	187V	185.4V
Ripple in Output Current	2.6A	3A
Overlap Angle	36.95 °	32.5 °



Result: Due to the source inductance there is reduction in output voltage observed.

SIMULATION OF PHASE CONTROLLED RECTIFIER ON MATLAB / SIMULINK

Objective: The objective of this experiment is to study the operation of single-phase controlled rectifiers using MATLAB/SIMULINK.

Parameters:

Parameter	Value
Input voltage	230 V, 50 Hz
Source Inductance	10 mH
Case 1: Load & Firing angle α = 30	20 Ω in series with 200 mH Inductance
Case 2: Load & Firing angle α = 60	20 Ω in series with 200 mH Inductance
Case 3: Load, L_s & α = 30	20 Ω in series with 200 mH inductance & L_s =10mH

Theory: Rectifier is a AC to DC converter. In this converter we are using diode so we do not have controlled output so it is an uncontrolled rectifier.

Avg. Output Voltage:

$$V_o = \frac{V_m}{\pi}(1+\cos\alpha) \qquad \text{valid for R load}$$

Where V_m is maximum input voltage.

Avg. Output Voltage:

$$V_o = \frac{2V_m}{\pi}\cos\alpha \qquad \text{valid for continuous conduction}$$

Overlap angle μ (when source inductance present):

$$\cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_s I_o}{V_m}$$

Design procedure and final design parameters obtained:

- In positive half cycle of input voltage, Thyristor T_1 and T_2 conducts, so

$$V_o = V_{in}$$

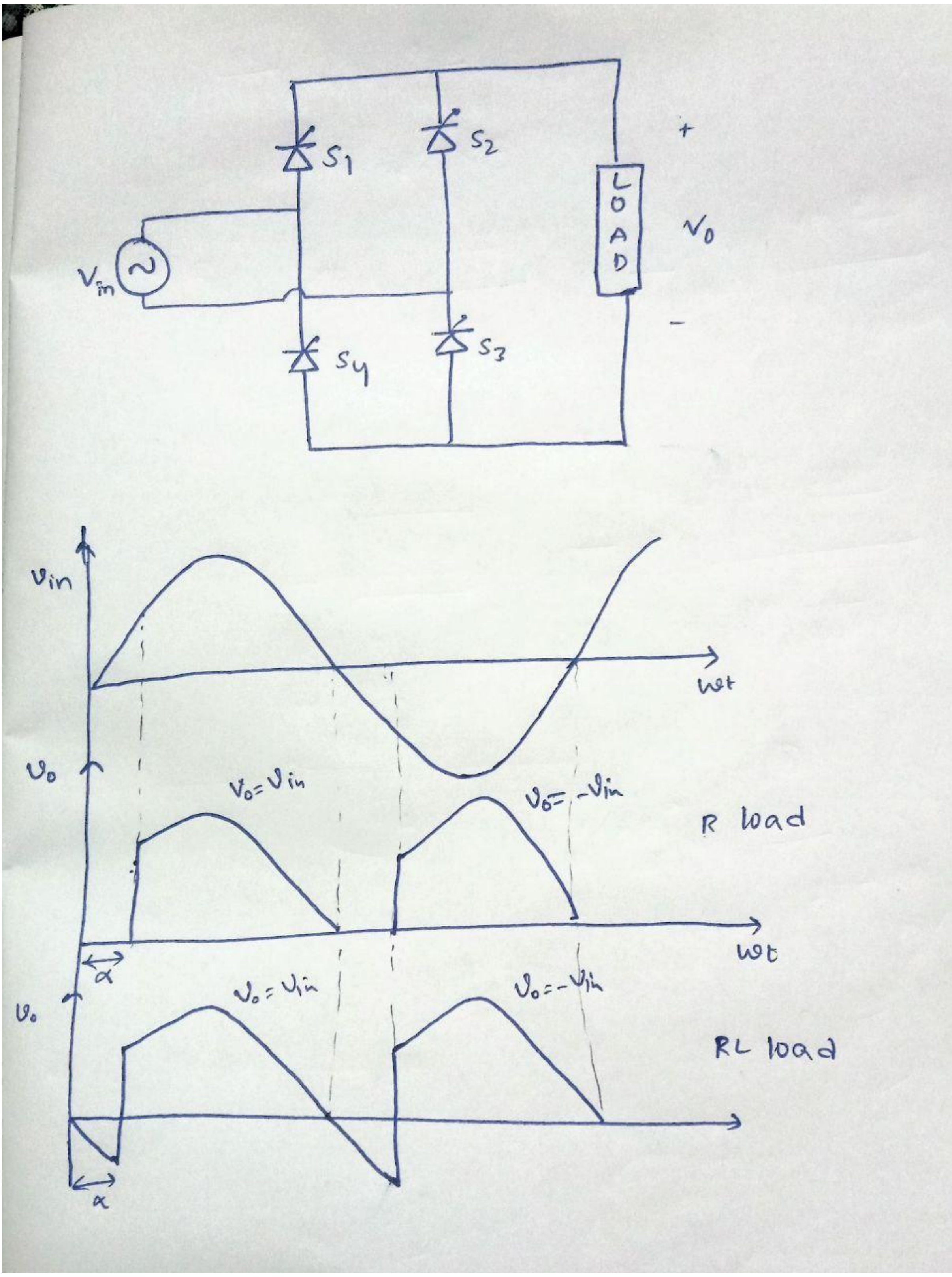
- In negative half cycle of input voltage, Thyristor T_3 and T_4 conducts, so

$$V_o = -V_{in}$$

- Here we are taking 100 Samples for each Time period So, Sampling frequency is 100 times of maximum frequency(100Hz).

So, Sampling Time Period = 100μSec.

Circuit Diagram and Theoratical Waveforms:



Simulation Model:

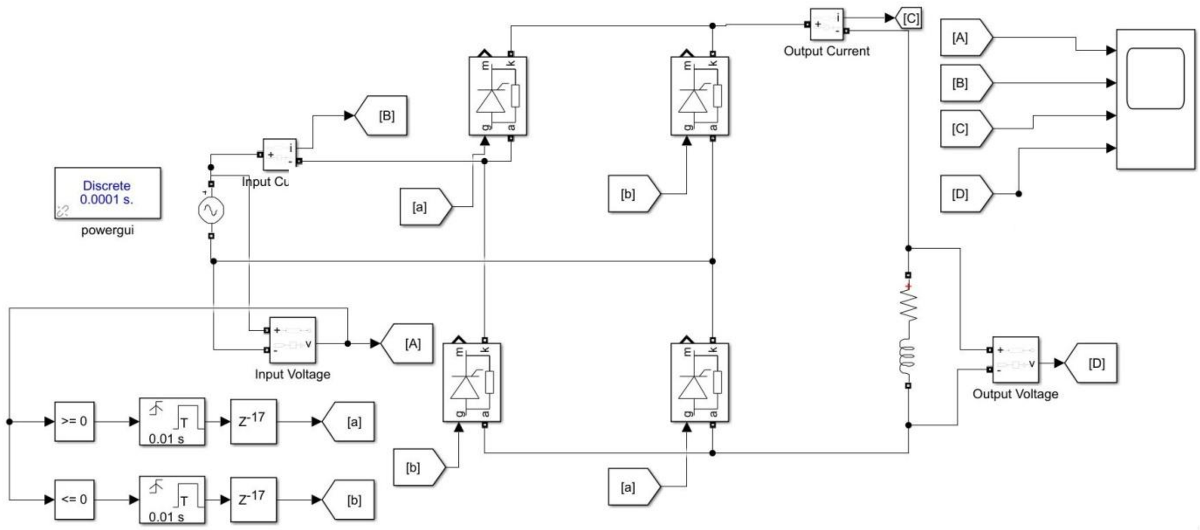


Fig.2 Simulation model without source inductance (α=30°)

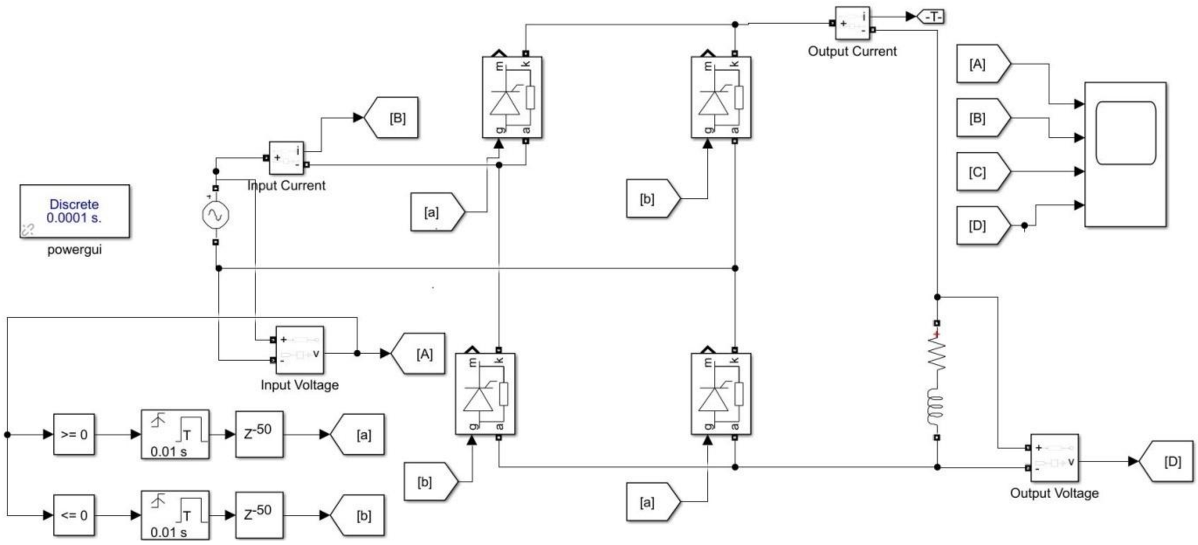


Fig.3 Simulation model without source inductance (α=90°)

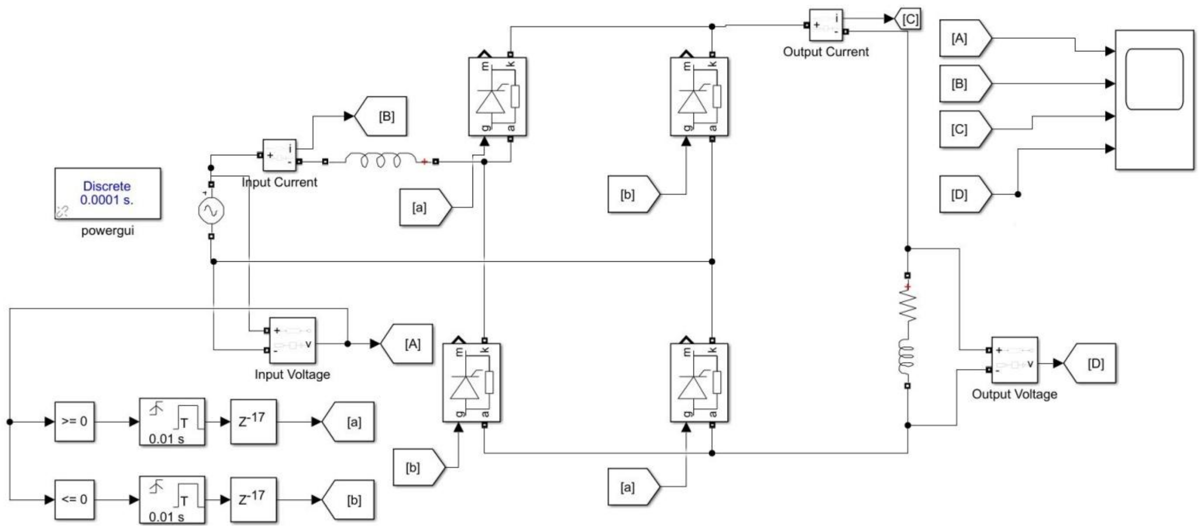
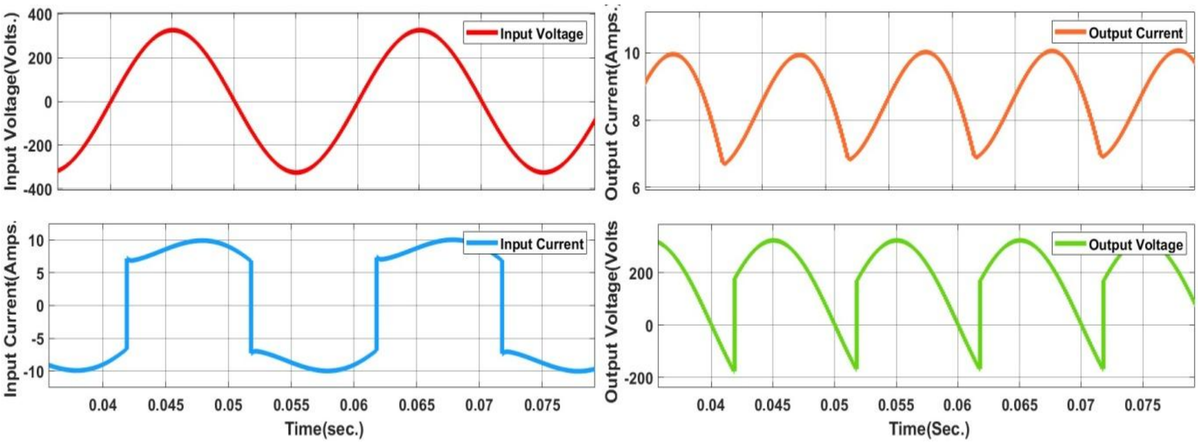


Fig.3 Simulation model with source inductance (α=30°)

Waveforms and Results:

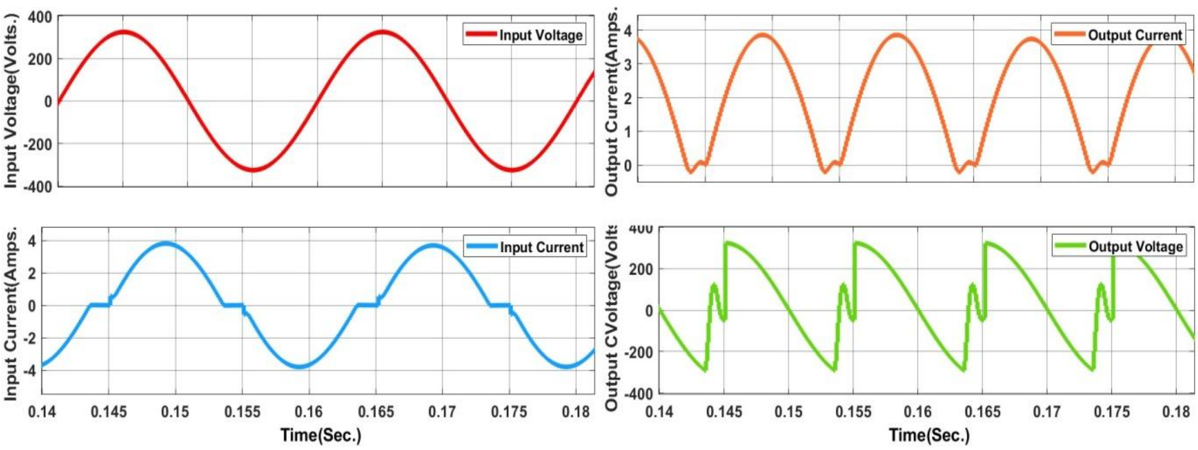
Case 1: Load 1 (R=20Ω & L=200mH) (α=30°)

	Theoratical	Practical
Avg. Output Voltage	179.33V	177.5V
Ripple in Output Current	8.96A	10.2A



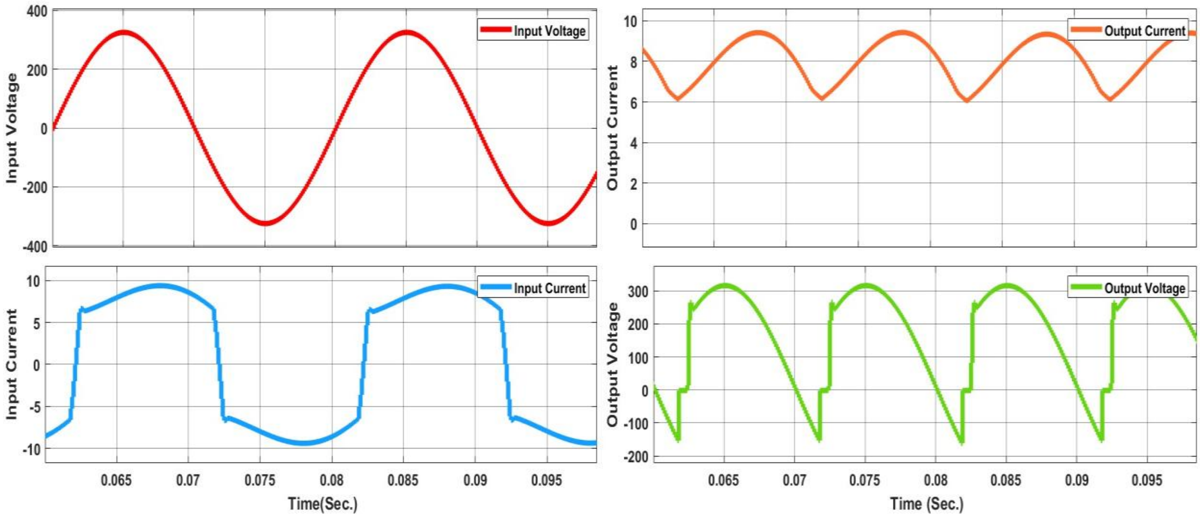
Case 2 : Load 2 (R=20Ω & L=200mH) (α=90°)

	Theoratical	Practical
Avg. Output Voltage	103.53V	101.2V
Ripple in Output Current	5.17A	7.3A



Case 4 : Load 3 (R=20Ω & L=200mH) with Source Inductance (L_s) (α=30°)

	Theoratical	Practical
Avg. Output Voltage	166V	164.8V
Ripple in Output Current	3.25A	3A
Overlap Angle	9°	12°



Result: Due to the source inductance there is reduction in output voltage observed.