COLLEGE OF ENGINEERING & TECHNOLOGY

LABORATORY MANUAL

POWER ELECTRONICS

SUBJECT CODE: 3140915

ELECTRICAL ENGINEERING DEPARTMENT

B.E. 4th SEMESTER

NAME:____

ENROLLMENT NO: ________________________________

BATCH NO: ____________________________________

YEAR: ______________________________________

Amiraj College of Engineering and Technology,

Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

Amiraj College of Engineering & Technology

Amiraj College of Engineering and Technology,

Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

CERTIFICATE

This is to certify that Mr. / Ms. ____ Of class___________________ Enrolment No __________________________has Satisfactorily completed the course in ___________________________________as by the Gujarat Technological University for ____ Year (B.E.) semester___ of Electrical Engineering in the Academic year____________.

Date of Submission:-

Faculty Name and Signature

(Subject Teacher)

Head of Department

(Electrical)

COLLEGE OF ENGINEERING & TECHNOLOGY

MECHANICAL ENGINEERING DEPARTMENT

B.E. 4th SEMESTER

SUBJECT: POWER ELECTRONICS

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List of Experiments

Sr. No.	Title	Date of Performance	Date of submission	Sign	Remark
1	To verify the V-I characteristics of silicon control rectifier (SCR)				
2	To verify the UJT as a relaxation oscillator				
3	To Perform 3-phase ac power control by TRIACS with lamp load				
4	To perform the 1-phase full wave fully controlled bridge rectifier configuration with “R/RL load & FWD”				
5	To perform the 3-Phase full wave half controlled thyristor bridge converter				
6	To simulate Single phase half bridge inverter using MATLAB				
7	To simulate Single phase full bridge inverter using MATLAB				
8	To generate PWM signal using MATLAB				
9	To study AC Voltage Controller				
10	To study 1-phase Half wave controlled DC motor control				

EXPERIMENT– 1

AIM: To verify the V-I characteristics of silicon control rectifier (SCR)

APPARATUS: Experimental training kit, connecting wires.

PROCEDURE:

1. Make the connection for SCR as shown in **Figure 1.**
2. Keep both variable power supply knob “V_{AA}” and “V_{GG}” to its minimum position.
3. Switch on the kit.
4. Keep gate current Ig to zero and vary the voltage V_{AA} from zero to maximum value in steps.
5. Note readings of V_{AK} & I_A. The SCR remains on OFF state i.e. I_A remains almost zero.
6. Now set V_{AK} to 10Vdc.
7. Now apply V_{GG} and slowly vary the Gate current Ig. Note Ig value at which SCR turns on. As soon as SCR turns ON, voltage across SCR “V_{AK}” falls to a very low value i.e. approximately 0.7 to 1V.
8. Now increase V_{AA} in steps and take the readings of V_{AK} &I_A.
9. Once SCR is in ON state, it remains in ON state only. For turning it OFF, Switch off the kit i.e. power supply.
10. Repeat the step 5 & 6 for different values of V_{AK}.

    i.e. set V_{AK}= 25Vdc / 50Vdc.
11. Draw the graph of voltage across SCR $\mathbf{V_{AK}}$ to the corresponding anode current $\mathbf{I_A}$ for different value of gate current Ig.

OBSERVATION TABLE:

Sr. No.	Ig = 0		Ig1 =		Ig2 =	
	Voltage across SCR "V_{AK}"	Current flowing through SCR "I_A"	Voltage across SCR "V_{AK}"	Current flowing through SCR "I_A"	Voltage across SCR "V_{AK}"	Current flowing through SCR "I_A"
1			25Vdc	0	50Vdc	0
2						
3						
4						
5						
6						
7						
8						

CONCLUSION:

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EXPERIMENT– 2

AIM: To verify the UJT as a relaxation oscillator

APPARATUS: Experimental training kit, Connecting wires, Dual Trace CRO

PROCEDURE:

1. Select the Capacitor "C" by proper jumper wire. (0.1μF, 0.22μF, 0.47μF or 1μF)
2. Select the resistance "R" by proper jumper wire. (10KΩ, 22 KΩ, 33KΩ, 47 KΩ or 100 KΩ)
3. Connect the one channel of CRO across the capacitor "C" and second channel of CRO across the resistor "R_1".
4. Switch on the kit.
5. Adjust the time multiplier selector switch & voltage multiplier selector switch appropriately so that the waveforms can be observed on the screen of DRO.

   Refer Figure 1 for UJT oscillator diagram and Figure 2 for the waveform across capacitor "C" & resistor "R_1".

6. Now vary the resistor "R" and observe the waveforms.
7. Measure the peak point voltage, valley point voltage from the capacitor voltage "Vc". Calculate $\eta = (Vp – Vd)/VBB$.

   Take Vd=0.7V and VBB=12V and Vp is to be measured from the "Vc".

8. Measure the time period of the waveform and compare it with theoretical value of time period $T = RC\ln\{1/(1-\eta)\}$.

9. Take the readings for the different values of resistor "R" and capacitor "C".
10. At resistance "R" = 10KΩ, the oscillator may or may not oscillate.

OBSERVATION TABLE:

Capacitor "C" = _____

Peak point voltage Vp = ______

Valley point voltage Vv = ______

Intrinsic Standoff ratio "" = ______

Sr. No.	Resistor "R"	Measured time Period "T"	Calculated Time Period "T" = RCln{1/(1-)}
1.			
2.			
3.			
4.			
5.			

CONCLUSION:

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EXPERIMENT– 3

AIM: To Perform 3-phase ac power control by TRIACS with lamp load

APPARATUS: Experimental training kit, AC Voltmeter (0-240Vac), Bulb 60W – 3 Nos.

PROCEDURE:

1. For connection refer **Figure.**
2. Keep variable resistance "Firing angle adjustment" Potentiometer to its minimum position. i.e. Fully anti-clockwise position.
3. Switch on the 3 Phase Power source.
4. Observe that bulb is OFF and measure AC voltage across bulb.
5. Now slowly vary the "Firing angle adjustment" Potentiometer and observe that voltage across bulb increases and intensity of the light also increases.
6. Measure voltage across Triac and output controlled AC voltage across bulb.
7. Here, Diac is used to trigger the main Power device Triac.
8. "RC" triggering circuit is used to trigger the Diac and Diac triggers Triac.
9. By changing the value of "Firing angle adjustment" Potentiometer, the trigger (firing) angle of the Triac is controlled, thus controlling the AC voltage across the lamp load.
10. Carefully observe following voltages on CRO one by one
    a. Input Voltage, i.e. 230Vac (Phase to Neutral)
    b. Voltage across load, i.e. Lamp : VL
    c. Voltage across Triac : VT

Calculations:

CONCLUSION:

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SIGNATURE

EXPERIMENT– 4

AIM: To perform the 1-phase full wave fullycontrolled bridge rectifier configuration with "R/RL load & FWD"

APPARATUS: Experimental training kit, Connecting wires, DC Voltmeter (0-100Vdc), CRO Dual channel

PROCEDURE:

Part –I, With "R" load.

1. UJT synchronized triggering circuit is used to trigger the thyristors.
2. Short the Inductor "L" of 1 Henry by proper Jumper wire.
3. Keep the Firing angle adjust potentiometer i.e. variable resistor "R" to its minimum position.
4. Switch on the kit.
5. Observe the waveform in the following sequence and draw the same also.
   a. Input voltage, Vin=50Vac
   b. Zener voltage Vz
   c. Capacitor Voltage Vc
   d. Voltage across "R" Load, VRL
6. Measure the triggering angle or firing angle of the SCR by using CRO and measure the DC voltage across the load by using DC voltmeter.
7. For changing the firing angle of the SCR, vary the potentiometer "R" and repeat the step No. 4 & 5 for different values of firing angle.
8. Switch OFF the trainer board i.e. kit.
9. Calculate the theoretical DC voltage across the load,
   $(VRL)dc = Vm(1+\cos\alpha)/\pi$

Part –II, With "RL" load.

1. Remove the Short Jumper wire from the Inductor "L".
2. Keep the Firing angle adjust potentiometer i.e. variable resistor "R" to its minimum position.

3. Switch on the kit.
4. Observe the waveform in the following sequence and draw the same also.
   a. Input voltage, Vin=50Vac
   b. Zener voltage Vz
   c. Capacitor Voltage Vc
   d. Voltage across “RL” Load, VRL
5. Measure the triggering angle or firing angle “α” of the SCRs and the turn off angle “β” of the SCRs by using CRO and measure the DC voltage across the load by using DC voltmeter.
6. Because of Inductive load, the Thyristors are not able to turn off at the zero crossing but continue to remain in conduction during the negative cycle also till current falls below the it’s holding current value, approximately zero.
7. For changing the firing angle of the SCR, vary the potentiometer “R” and repeat the step No. 13 & 14 for different values of firing angle.
8. Switch OFF the trainer board i.e. kit.

Part –III, With “RL” load and FWD.

1. Keep the same set up as for the “RL” load but in addition connect the Free Wheeling diode (FWD) across the load.
2. This FWD helps thyristor to turn off at the zero crossing. The stored energy free wheels through this additional reverse biased diode connected across the “RL” load.
3. Observe the waveform in the following sequence and draw the same also.
   a. Input voltage, V_{in}=50V_{ac}
   b. Zener voltage V_z
   c. Capacitor Voltage V_c
   d. Voltage across “RL” Load, V_{RL}
4. The waveforms are same as of with “R” load. i.e. performance of the converter with “R” load is equivalent to the converter with “RL” load & FWD.

CALCULATIONS:

CONCLUSION:

DATE: / /

SIGNATURE

EXPERIMENT– 5

Aim: To perform the 3-Phase full wave half controlled thyristor bridge converter

APPARATUS: Experimental training kit, Connecting wires, DC Voltmeter, CRO- Dual channel

PROCEDURE:

Part – I, With "R" load.

1. Refer the circuit diagram as shown in figure.
2. Short the Inductor "L" of 1 Henry by proper Jumper wire.
3. Switch on the kit.
4. Observe the waveform in the following sequence and draw the same also.
   a. Input voltage, Vin=50Vac
   b. Pulses to the Thyristors
   c. Voltage across "R" Load, VRL
5. For changing the firing angle of the SCR, vary the potentiometer "R" and repeat the step No. 4 for different values of firing angle.
6. Draw all above waveforms in a sequence for different value of firing angle.
7. Measure the DC voltage across the load for different firing angle.
8. Switch OFF the trainer board i.e. kit.

Part – II, With "RL" load.

1. Remove the Short Jumper wire from the Inductor "L".
2. Switch on the kit.
3. Observe the waveform in the following sequence and draw the same also.
   a. Input voltage, Vin=50Vac
   b. Pulses to the Thyristors
   c. Voltage across "R" Load, VRL
4. For changing the firing angle of the SCR, vary the potentiometer "R" and repeat the step No. 11 for different values of firing angle.

5. Draw all above waveforms in a sequence for different value of firing angle.
6. Because of Inductive load, the conducting Thyristor is not able to turn off at the zero crossing but continue to remain in conduction during the negative cycle also till current falls below the it's holding current value, i.e. approximately zero. So in case of "RL" load negative voltage appears across the load particularly when firing angle is nearer to π.
7. Measure the DC voltage across the load for different firing angle.
8. Switch OFF the trainer board i.e. kit.

Part – III, With "RL" load and FWD.

1. Keep the same set up as for the "RL" load but in addition connect the Free Wheeling diode (FWD) across the load.
2. This FWD helps thyristor to turn off at the zero crossing. The stored energy free wheels through this additional reverse biased diode connected across the "RL" load.
3. Observe the waveform in the following sequence and draw the same also.
    d. Input voltage, Vin=50Vac
    e. Pulses to the Thyristors
    f. Voltage across "RL" Load with FWD, VRL
4. The waveforms are same as of with "R" load. i.e. performance of the converter with "R" load is equivalent to the converter with "RL" load & FWD.

CALCULATIONS:

CONCLUSION:

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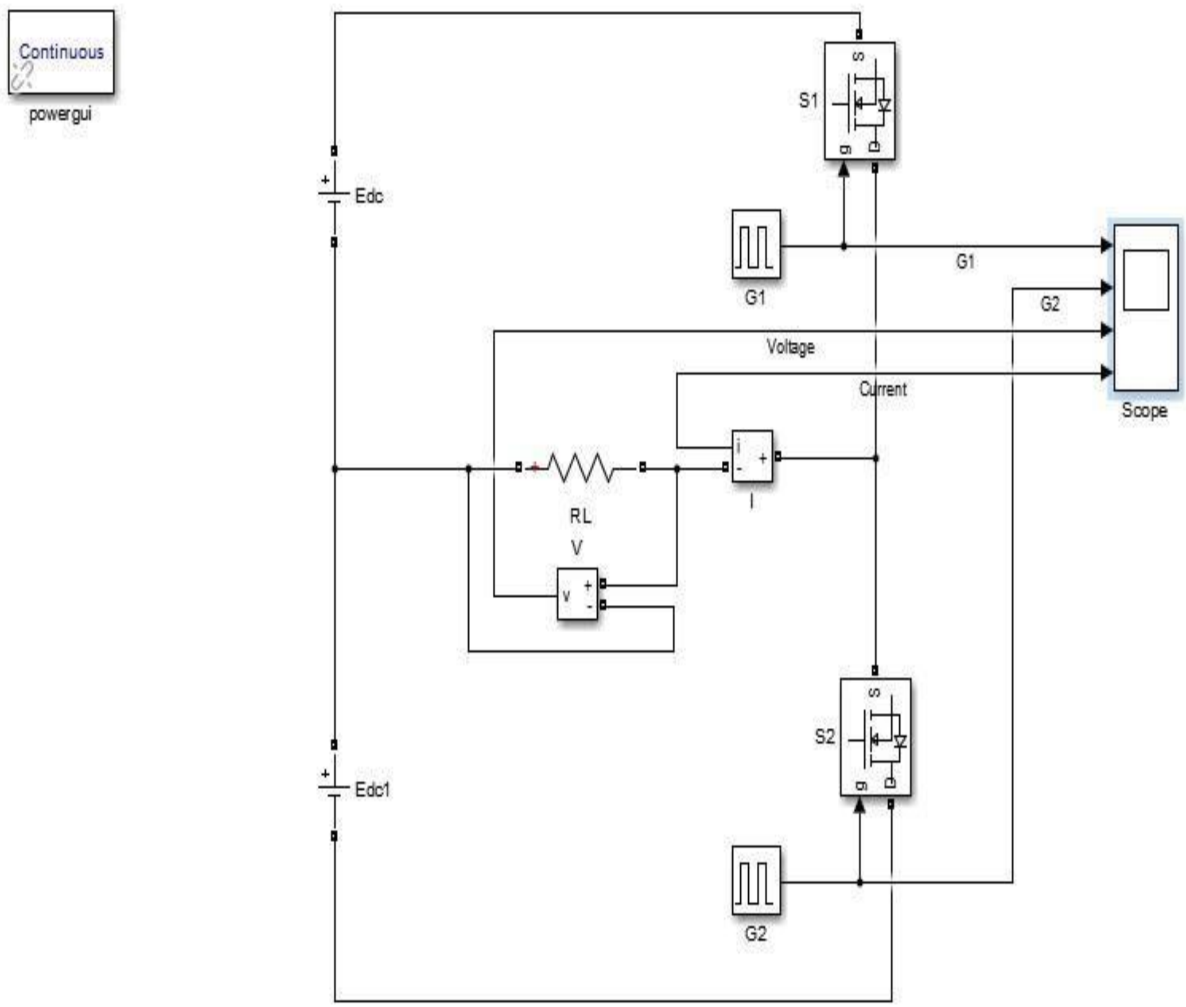
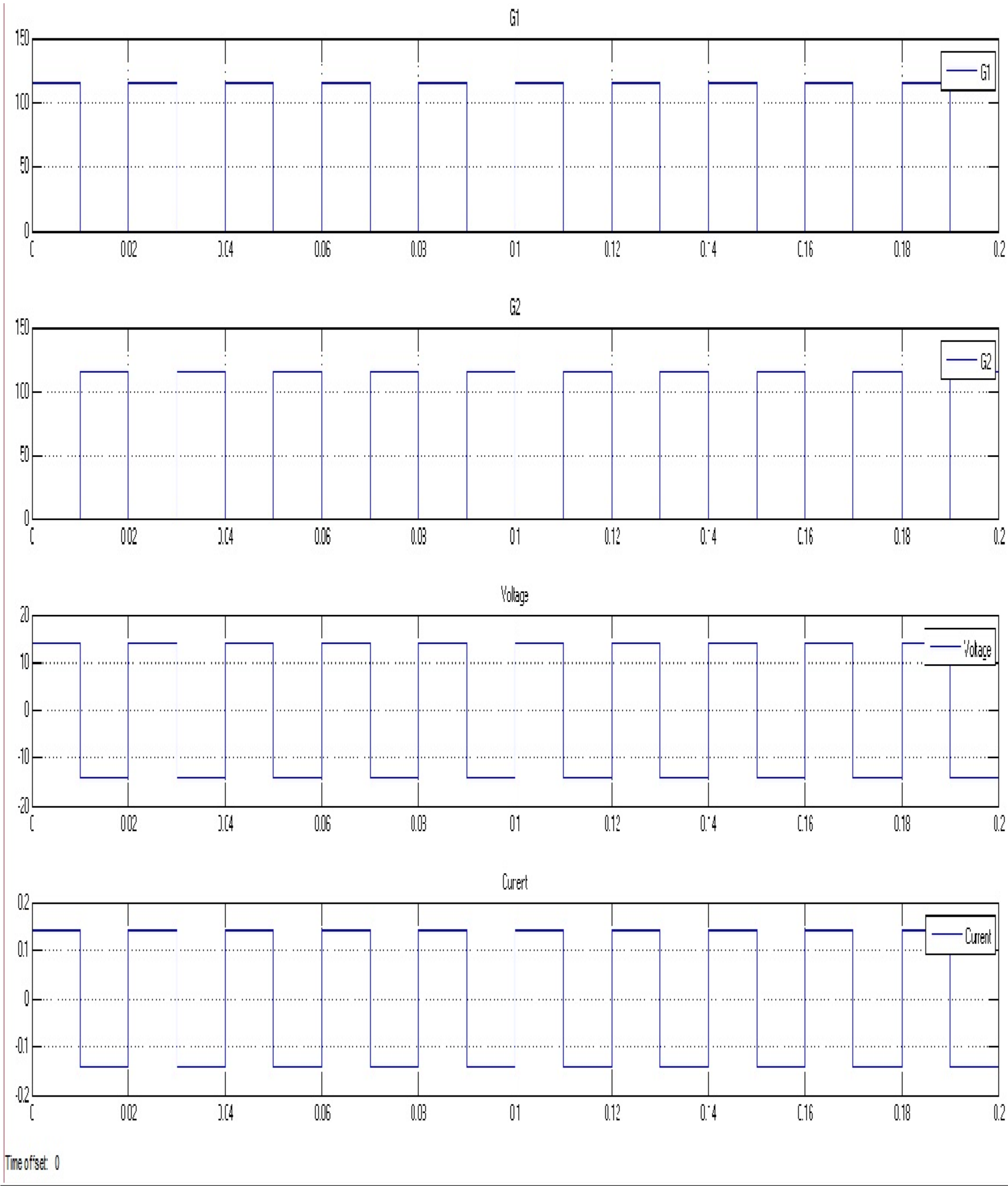
EXPERIMENT– 6

AIM: To simulate Single phase half bridge inverter using MATLAB.

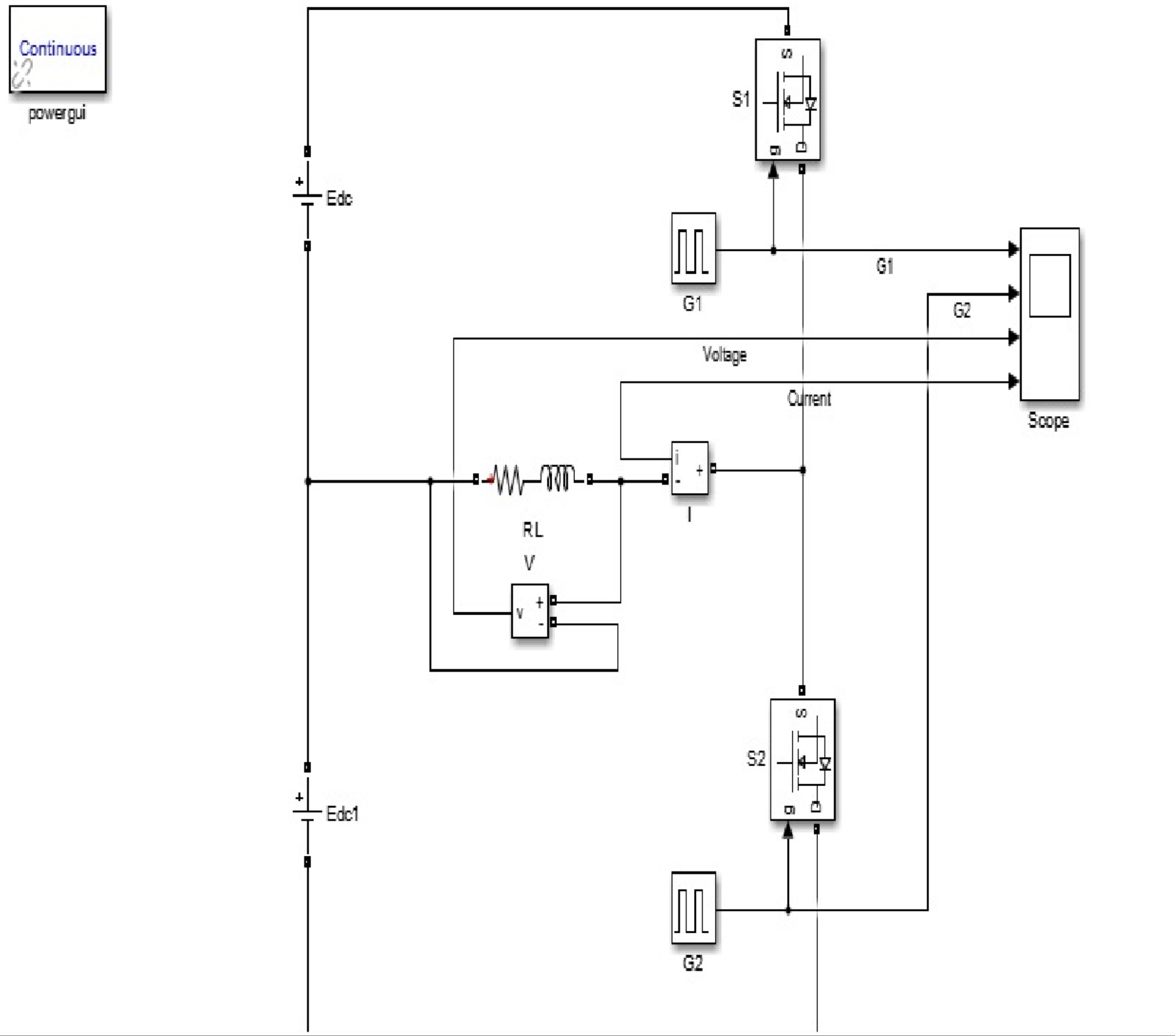
Single Phase Half Bridge Inverter with R Load:



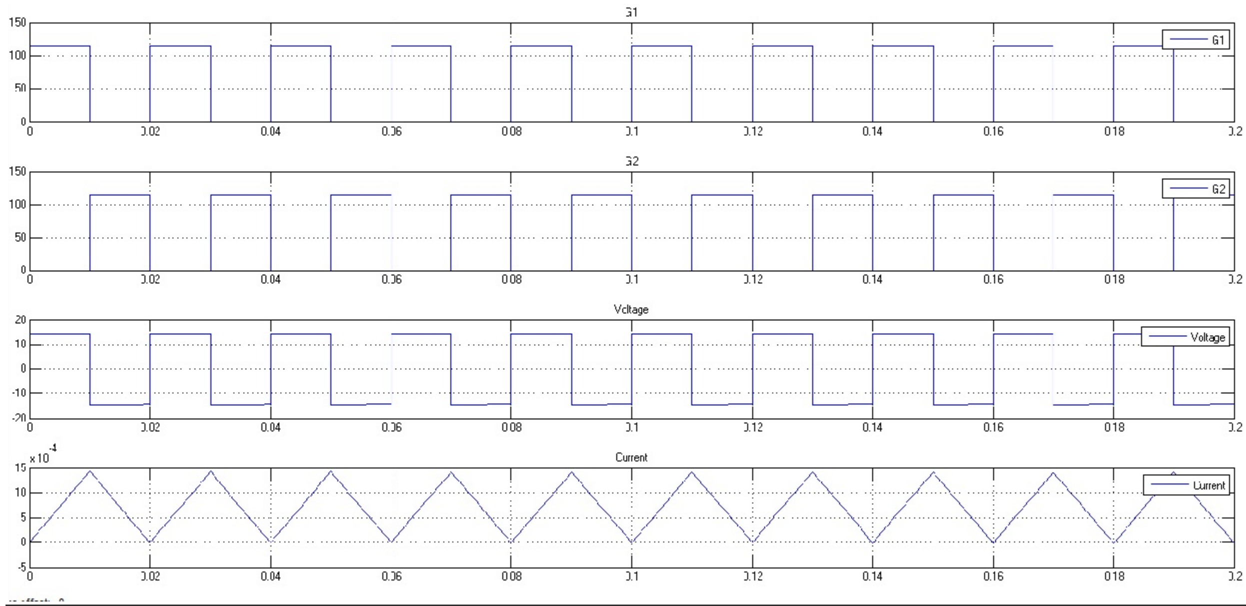
Waveforms:



Single Phase Half Bridge Inverter with RL Load:



Waveforms:



CONCLUSION:

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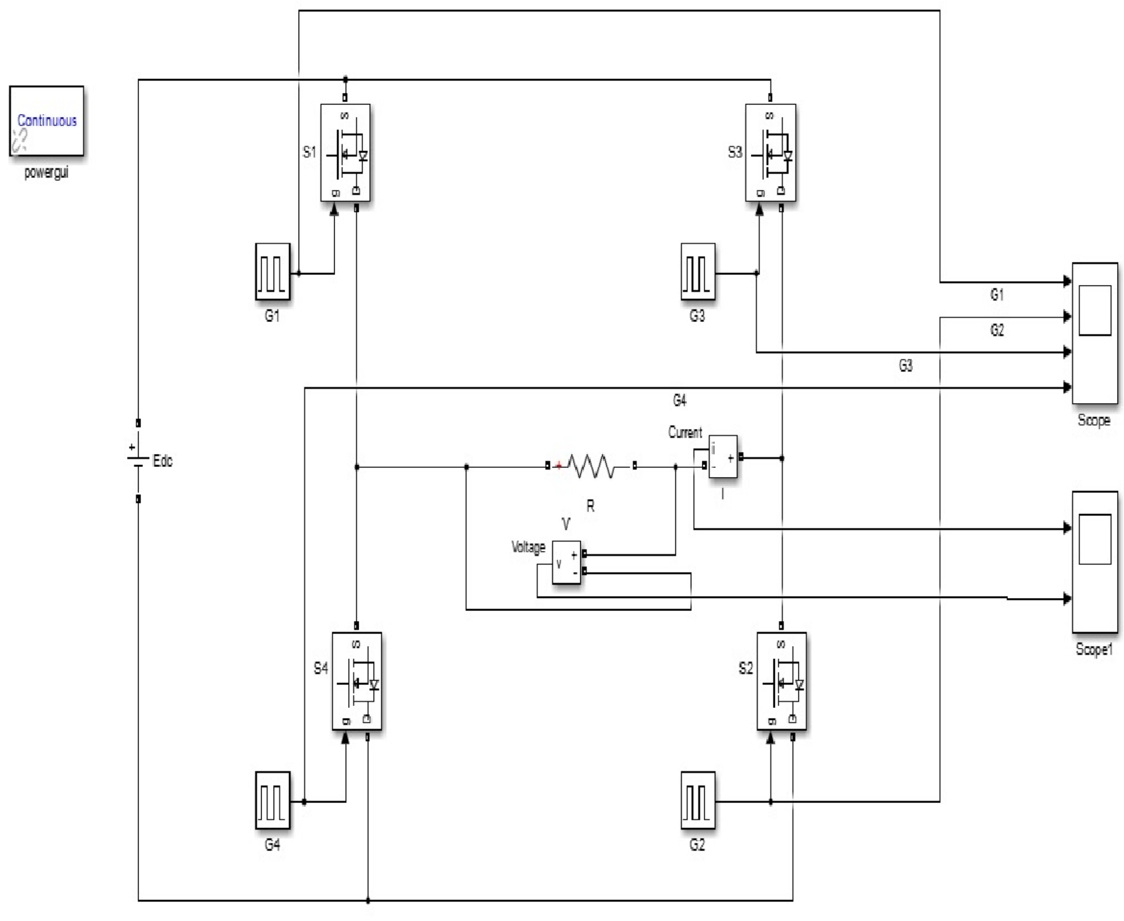
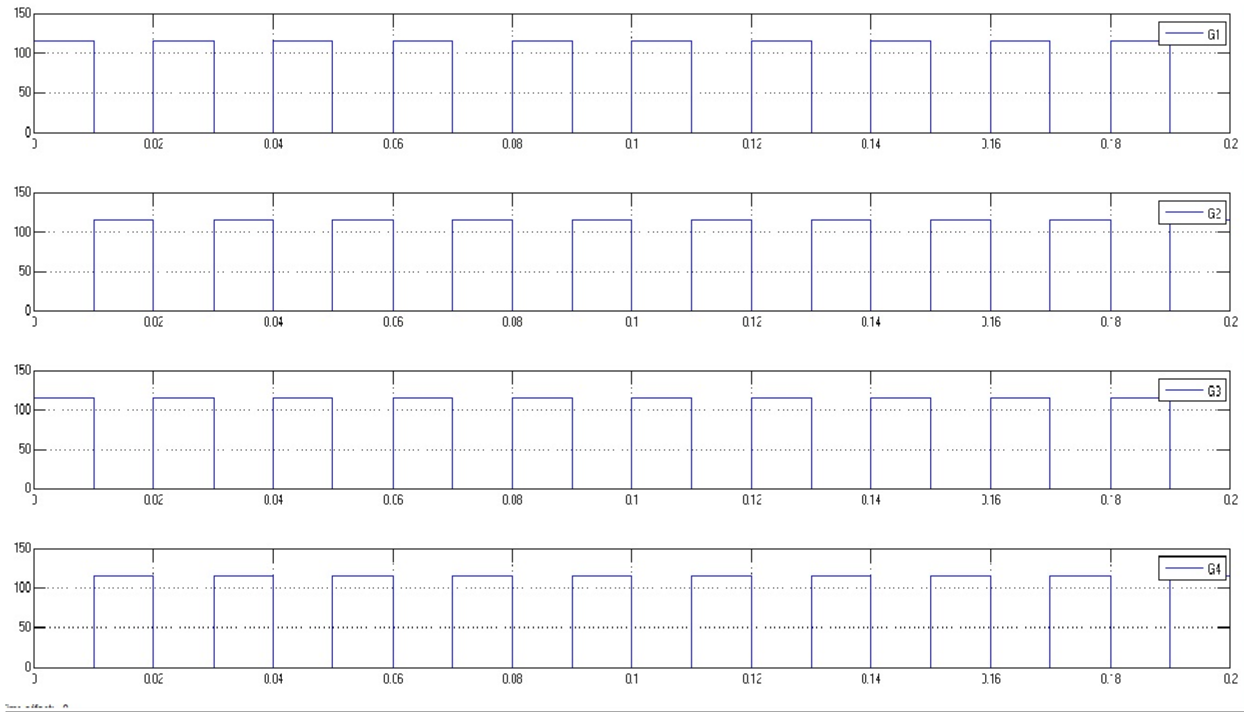
EXPERIMENT– 7

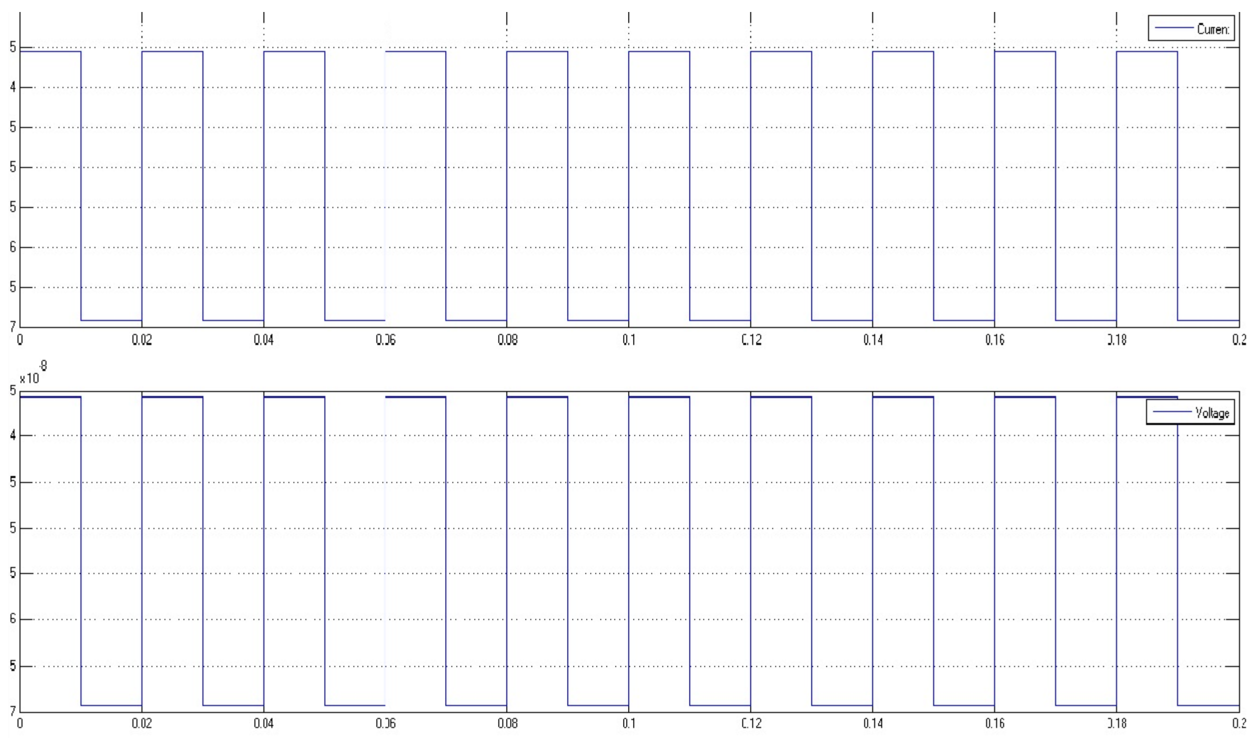
AIM: To simulate Single phase full bridge inverter using MATLAB.

Single Phase Full Bridge Inverter with R Load:



Waveforms:


G1
G2
G3
G4
150
100
50
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.2


Current
Voltage
0.02
0.04
0.08
0.1
0.14
0.16
0.2

CONCLUSION:

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EXPERIMENT– 8

AIM: To generate PWM signal using MATLAB.

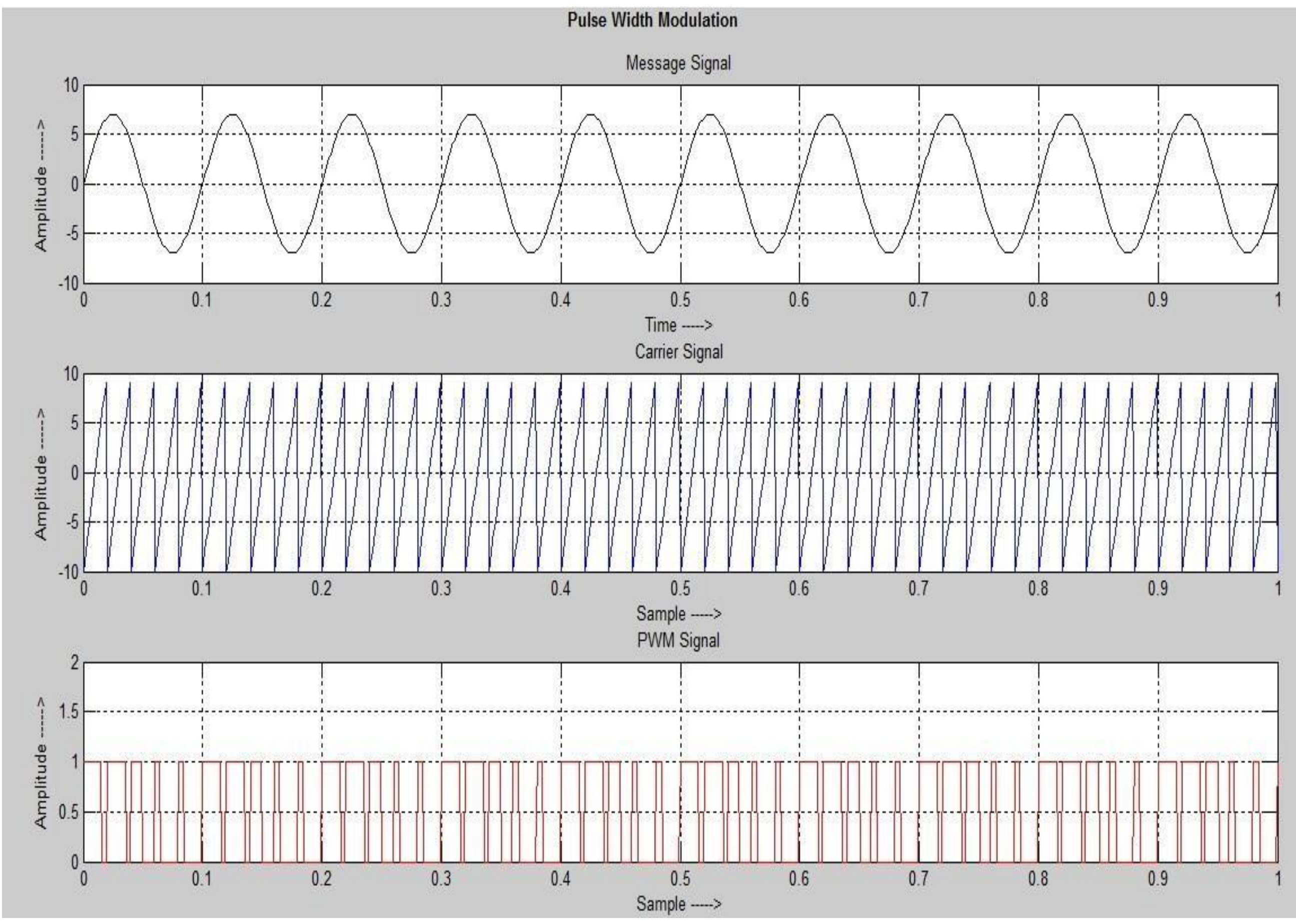
PROGRAM:

```
clc;
clear all;
t = 0:0.001:1;
fc = input('Enter the Frequency of Carrier Signal (Sawtooth) = ');
fm = input('Enter the Frequency of Message Signal (Sinusoidal) = ');
a = input('Enter the Amplitude of Carrier Signal = ');
b = input('Enter the Amplitude of Message Signal(should be < Carrier) = ');

vc = a.*sawtooth(2*pi*fc*t);
vm = b.*sin(2*pi*fm*t);
n = length(vc);
for i = 1:n
    if (vm(i)>=vc(i))
        pwm(i) = 1;
    else
        pwm(i) = 0;
    end
end

% Representation of the Message Signal
subplot(3,1,1);
plot(t,vm,'black');
xlabel('Time----- >');
ylabel('Amplitude----- >');
title('Message Signal');
%legend('Message Signal---- >');
grid on;

% Representation of the Carrier Signal
subplot(3,1,2);
plot(t,vc);
xlabel('Sample----- >');
ylabel('Amplitude----- >');
title('Carrier Signal');
%legend('Carrier Signal---- >');
grid on;

% Representation of the PWM Signal
subplot(3,1,3);
```

```
plot(t,pwm,'red');
xlabel('Sample----- >');
ylabel('Amplitude----- >');
title('PWM Signal');
%legend('PWM Signal---- >');
axis([0 1 0 2]);
grid on;
```

```
Enter the Frequency of Carrier Signal (Sawtooth) = 50
Enter the Frequency of Message Signal (Sinusoidal) = 10
Enter the Amplitude of Carrier Signal = 10
Enter the Amplitude of Message Signal(should be < Carrier) = 7
```

RESULTS:



CONCLUSION:

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EXPERIMENT– 9

AIM: - To study AC Voltage Controller.

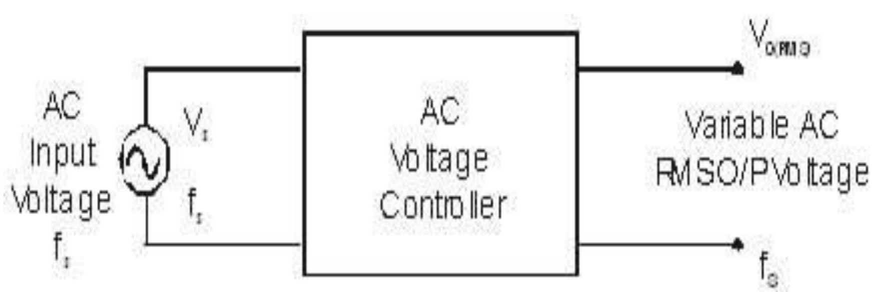
APPARATUS:

1. Power supply
2. Performance Kit
3. Multimeter
4. Probes
5. Oscilloscope

THEORY:

AC voltage controllers (ac line voltage controllers) are employed to vary the RMS value of the alternating voltage applied to a load circuit by introducing Thyristor between the load and a constant voltage ac source. The RMS value of alternating voltage applied to a load circuit is controlled by controlling the triggering angle of the Thyristor in the ac voltage controller circuits.

In brief, an ac voltage controller is a type of thyristor power converter which is used to convert a fixed voltage, fixed frequency ac input supply to obtain a variable voltage ac output. The RMS value of the ac output voltage and the ac power flow to the load is controlled by varying (adjusting) the trigger angle ‘α’



There are two different types of thyristor control used in practice to control the ac power flow

- On-Off control
- Phase control

These are the two ac output voltage control techniques. In On-Off control technique Thyristors are used as switches to connect the load circuit to the ac supply (source) for a fewcycles of the input ac supply and then to disconnect it for few input cycles. The Thyristors thus act as a high speed contactor (or high speed ac switch).

PHASE CONTROL

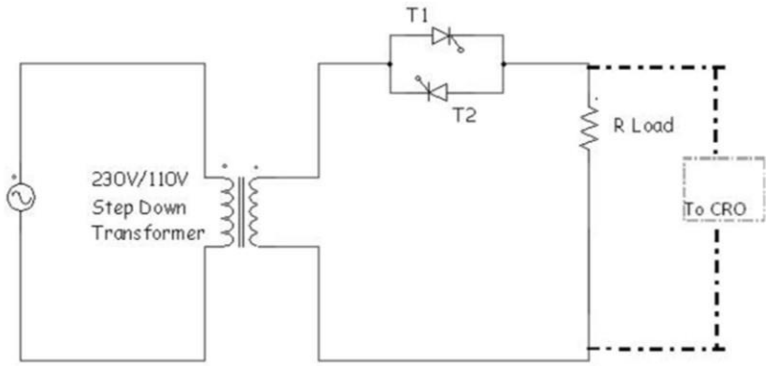
In phase control the Thyristors are used as switches to connect the load circuit to the input ac supply, for a part of every input cycle. That is the ac supply voltage is chopped using Thyristors during a part of each input cycle.

The thyristor switch is turned on for a part of every half cycle, so that input supply voltage appears across the load and then turned off during the remaining part of input half cycle to disconnect the ac supply from the load. (Delay angle), the output RMS voltage across the load can be controlled.$\alpha$by controlling the phase angle or the trigger angle.

The trigger delay angle 'α' is defined as the phase angle (the value t) at which the thyristor turns on and the load current begins to ω of flow. Thyristor ac voltage controllers use ac line commutation or ac phase commutation. Thyristors in ac voltage controllers are line commutated (phase commutated) since the input supply is ac. When the input ac voltage reverses and becomes negative during the negative half cycle the current flowing through the conducting thyristor decreases and falls to zero. Thus the ON thyristor naturally turns off, when the device current falls to zero.

Phase controlThyristors which are relatively inexpensive, converter grade Thyristors which are slower than fast switching inverter grade Thyristors are normally used. For applications upto 400Hz, if Triacs are available to meet the voltage and current ratings of a particular application, Triacs are more commonly used.

CIRCUIT DIAGRAM:



OBSERVATION TABLE:

Sr. No	Supply voltage	Firing Angle	$V_{O(avg)}$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

CONCLUSION:

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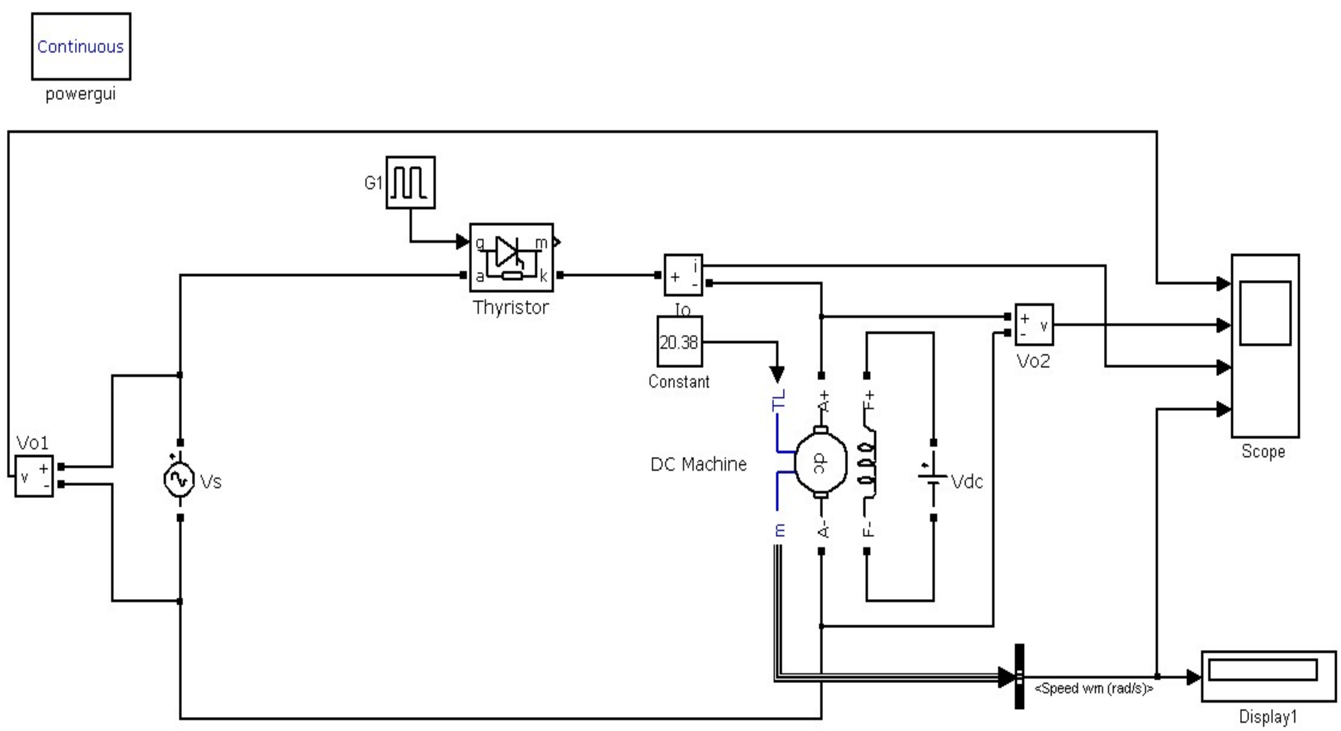
EXPERIMENT– 10

Aim:- To study 1-phase Half wave controlled DC motor control.

Motor Configurations:

Motor power	:-	5 H.P
Armature voltage	:-	240 V
Speed	:-	1750 RPM
Armature resistance	:-	0.781 Ω
Field Voltage	:-	150 V

Circuit Diagram:-



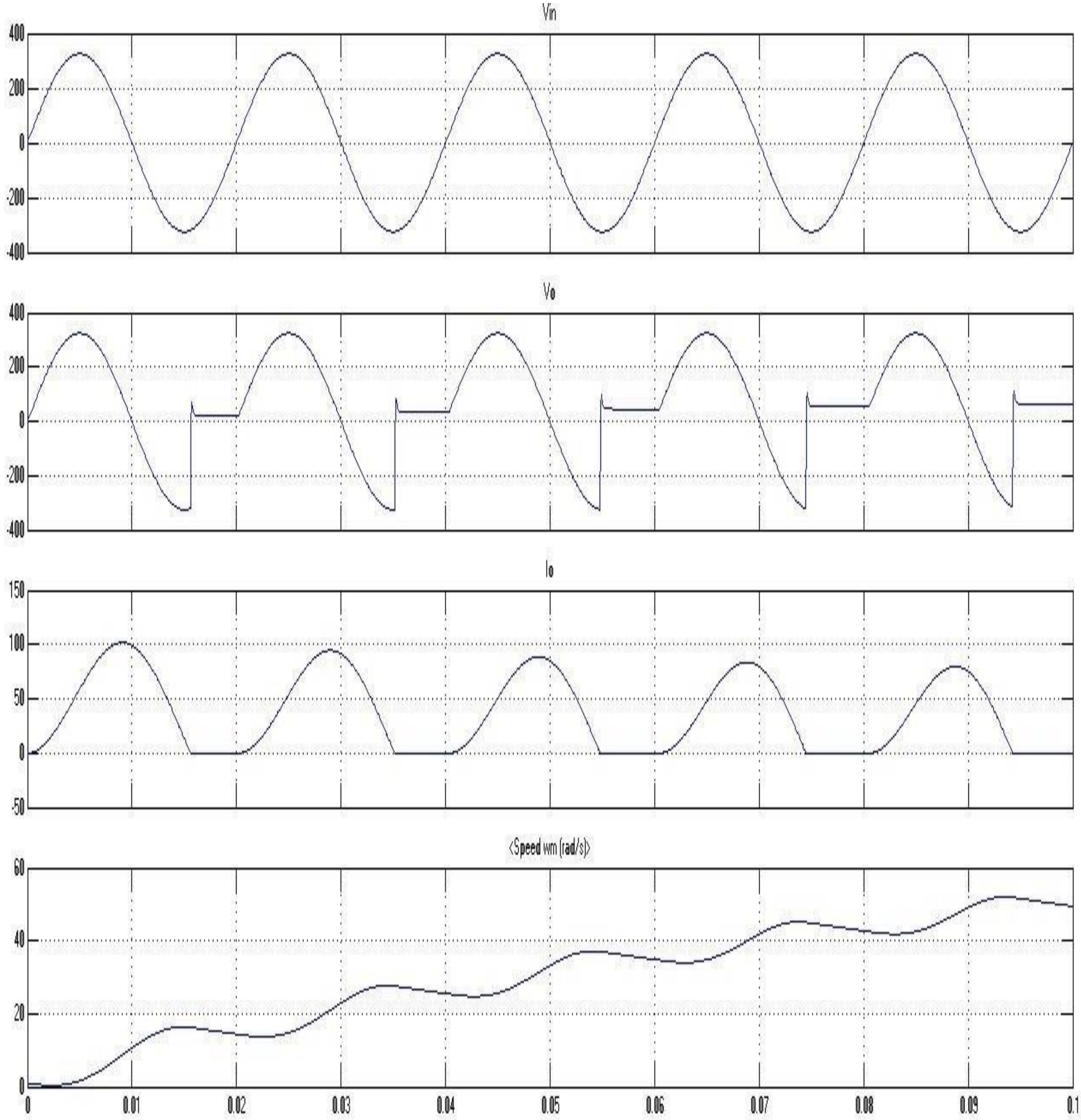


Figure-1 For firing angle= 0

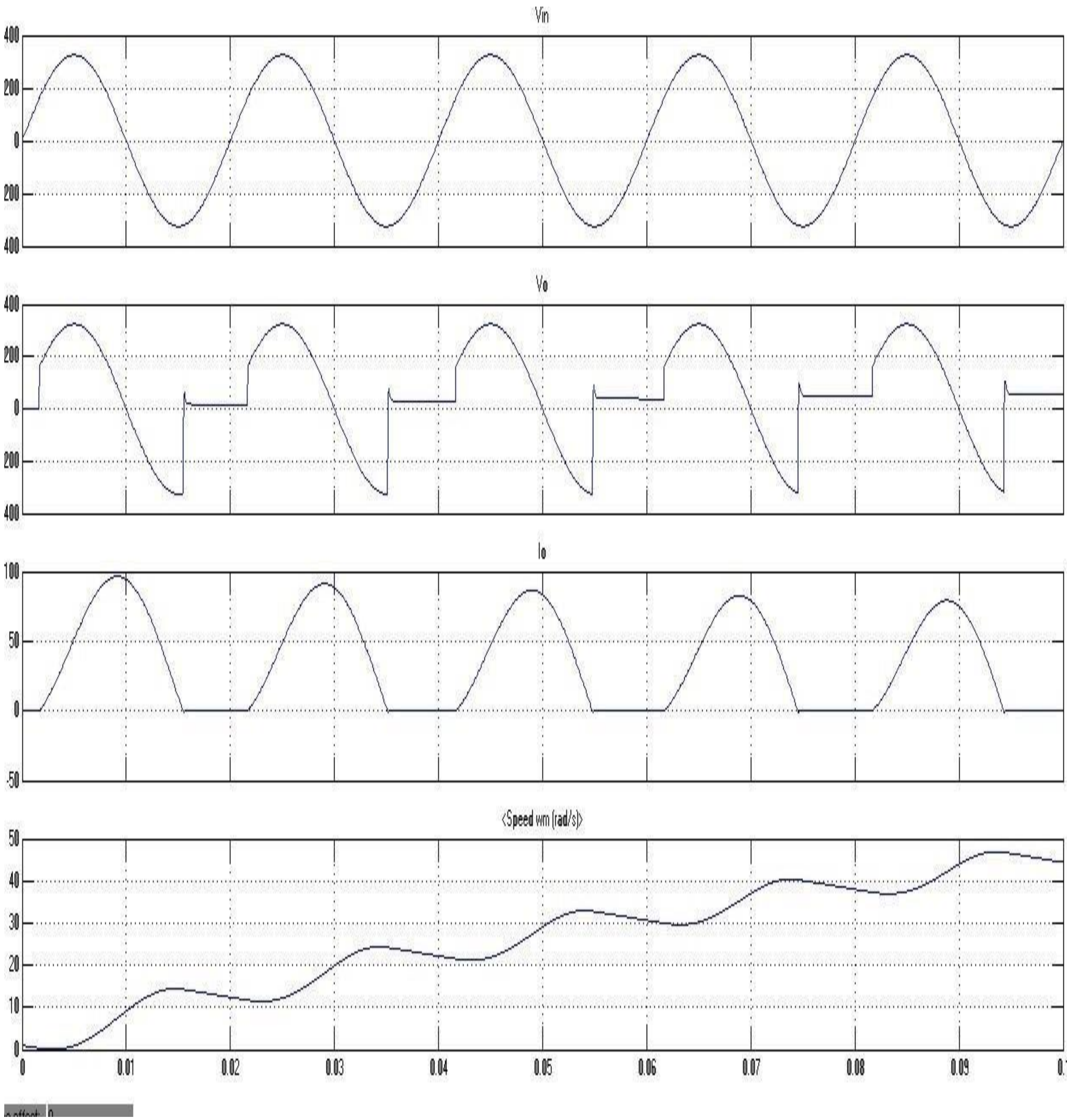


Figure-2 For firing angle= 30

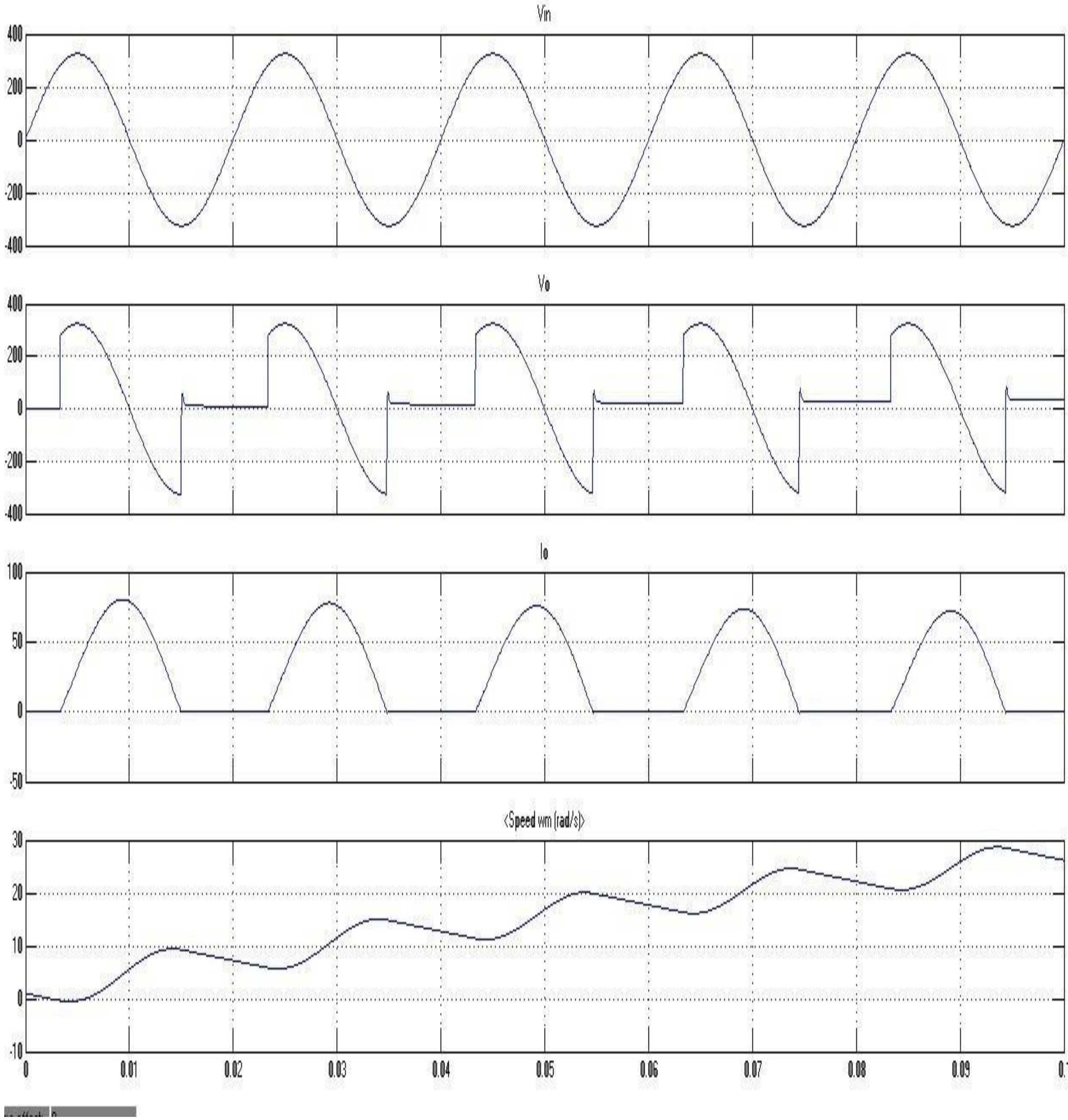


Figure-3 For firing angle= 60

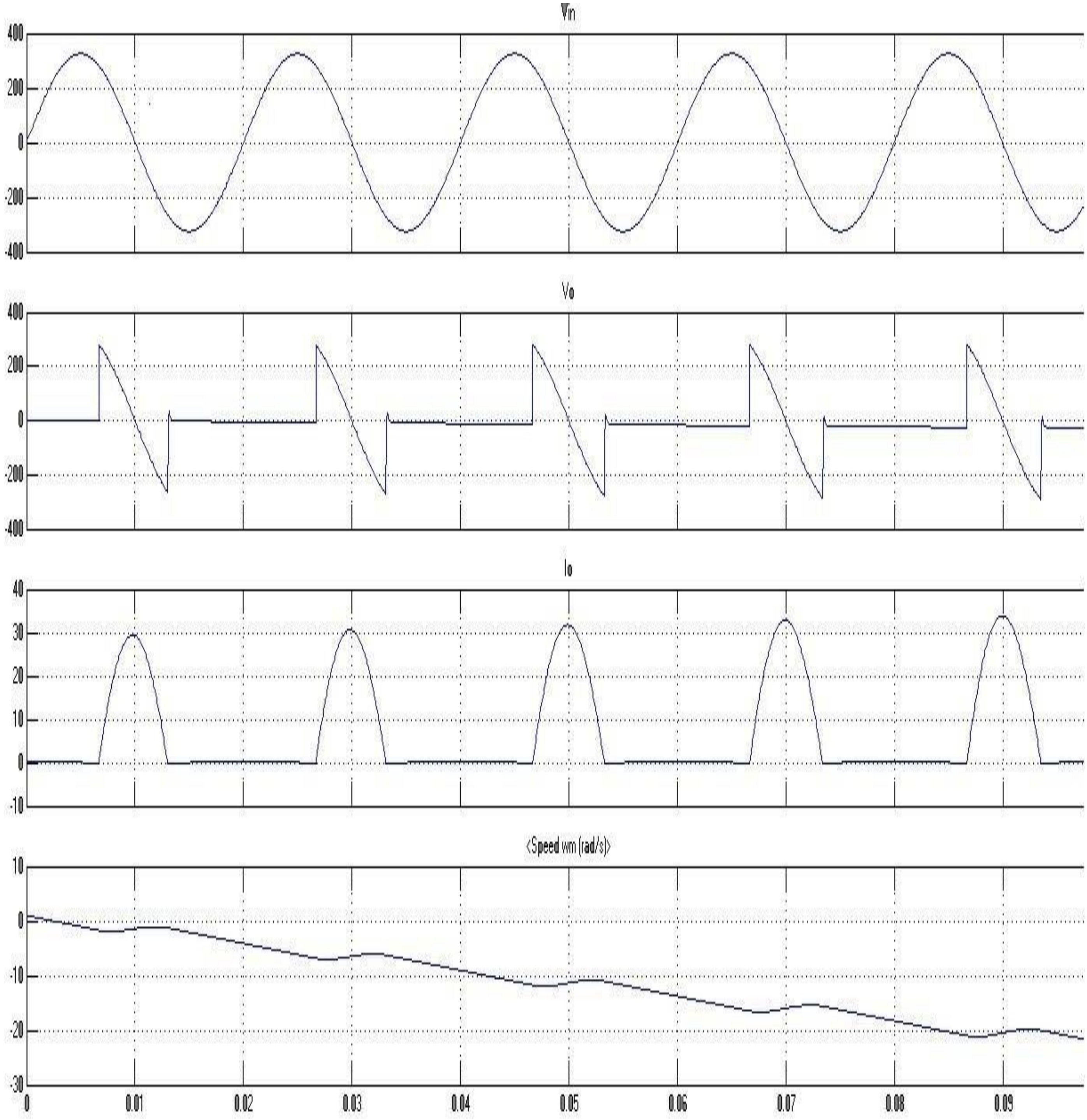


Figure-4 For firing angle= 90

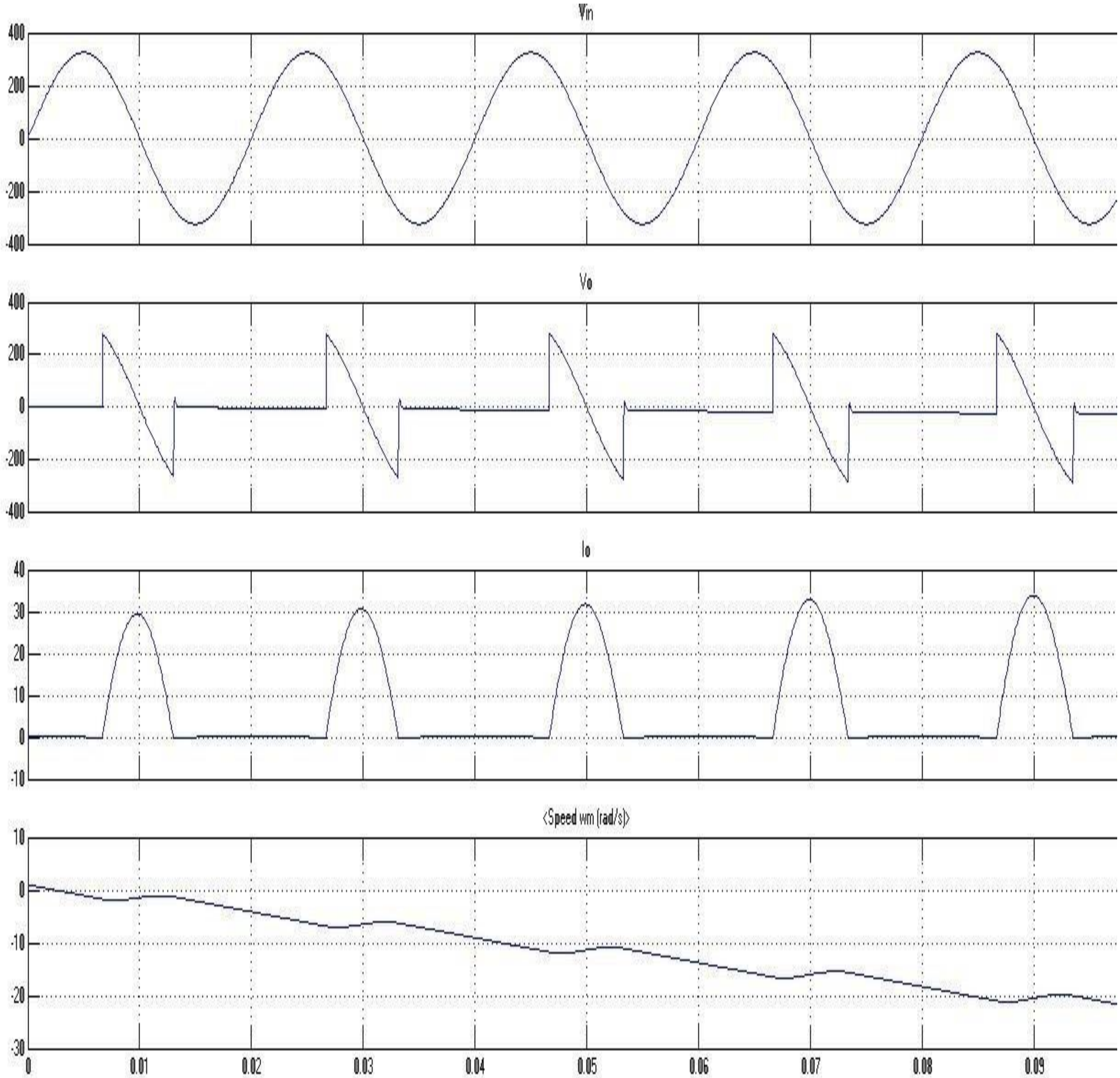


Figure-5 For firing angle= 120

Observation Table:

Firing Angle	Speed (rad/sec)

CONCLUSION:

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