Date: 29/03/22

EXPERIMENT NO: 05

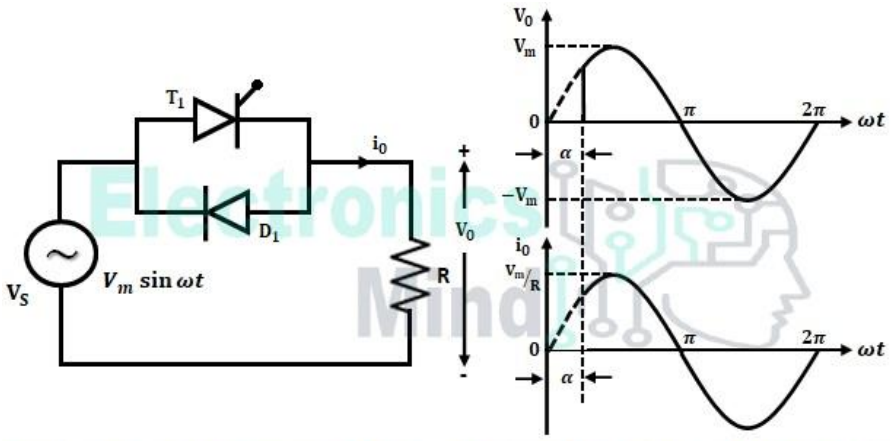
Study The Operation Of Ac Regulation Of R And R-L Load Of Single Phase Ac Motor Using Triac.

- OBJECTIVE : To study the operation of ac regulation of R and R-L load of single phase ac motor using TRIAC.

- THEORY :

Single Phase Half Wave AC Voltage Controller :

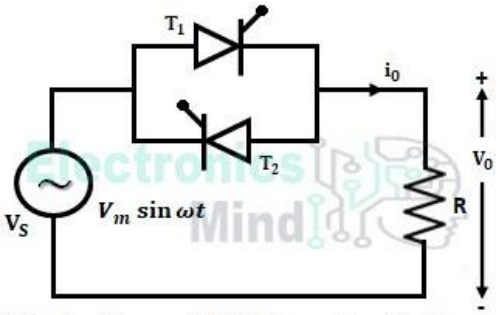
Single-phase half-wave ac voltage controller consists of one thyristor in anti-parallel with one diode. The power delivered to the load will depend upon the firing angle of the thyristor. The full-wave or bidirectional ac voltage controller uses two thyristors instead of one thyristor and diode. The two thyristors are connected in anti-parallel. Let see the working of full-wave ac voltage controller with resistive (R) load and resistive-inductive (RL) load.
The below shows the single-phase half-wave or undirectional ac voltage controller circuit with output voltage and current waveforms.



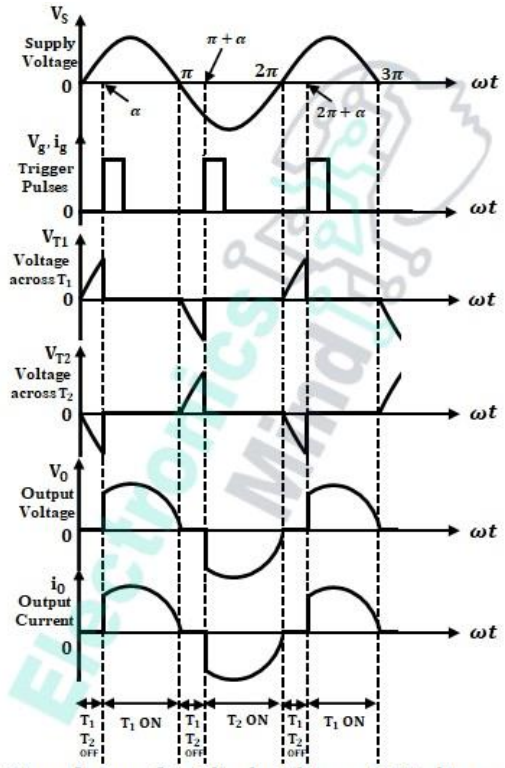
Single Phase Half Wave AC Voltage Controller Circuit and Waveforms

- **With R load :**

The power circuit diagram for a single-phase ac voltage controller with a resistive load is shown in the below figure. The power delivered to the load flows through thyristor T_1 during the positive half-cycle and through thyristor T_2 during the negative half-cycle.



Single Phase AC Voltage Controller With Resistive Load

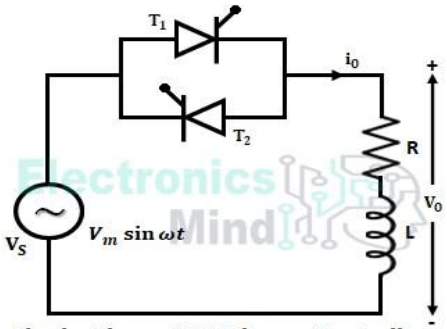


Waveforms for Single Phase AC Voltage Controller With Resistive Load

During the positive half cycle of the source voltage V_S, SCR T_1 is forward biased and SCR T_2 is reverse biased. No conduction of load current takes place until thyristor T_1 is triggered at some firing angle α. So, the entire supply voltage V_S appears across thyristor T_1 with the same polarity and across T_2 with the reversed polarity. As soon as the thyristor T_1 is triggered at the instant ωt = α, T_1 starts conducting and the entire supply voltage V_S, except the drop across T_1, appears across the load resistance.

- **With RL Load :**

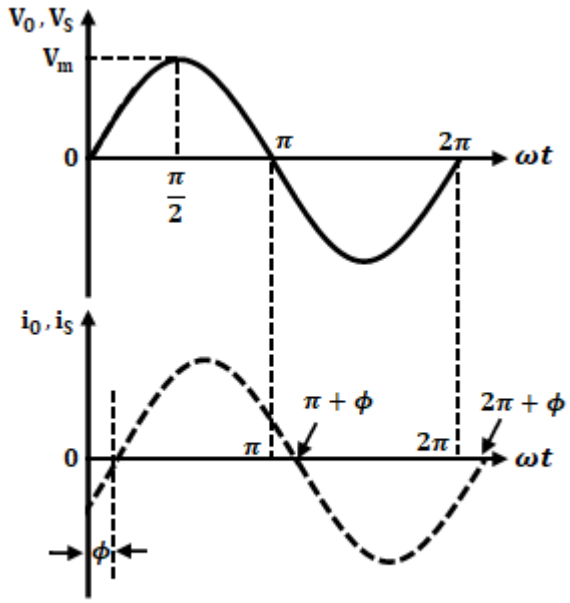
The below shows the single-phase ac voltage controller circuit with resistive and inductive load.



Single Phase AC Voltage Controller With RL Load

Operation When α ≤ Φ :

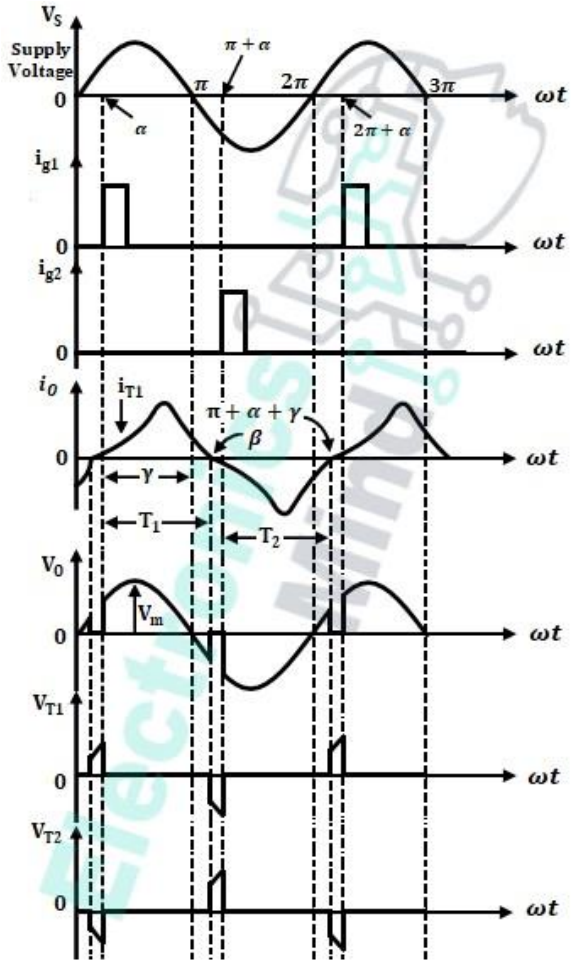
Consider α = Φ (load phase angle) i.e., the ac voltage regulator is operating under steady-state conditions. The conduction period of SCR T_2 is from zero to Φ and from Φ to (π + Φ) SCR T_1 will conduct and again from (π + Φ) to (2π + Φ) SCR T_2 will conduct as shown in the waveform below.



Waveforms for Single Phase AC Voltage Controller With RL Load When $\alpha \leq \phi$

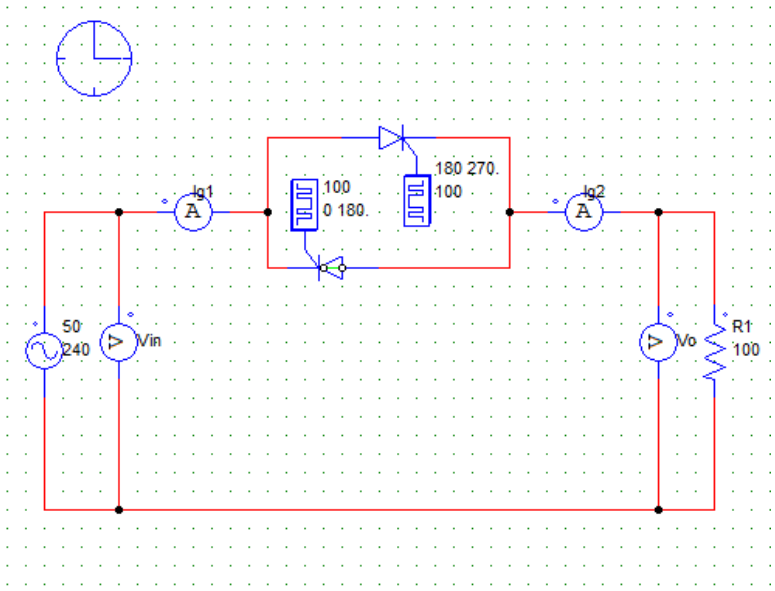
Operation When α > Φ :

The waveform for input voltage and currents along with their outputs when α > Φ is shown below. The current I_{g1} and I_{g2} are the gating signals applied. During the positive half-cycles i.e., from 0 to π, thyristor T_1 is forward biased and at angle ωt = α, thyristor T_1 is triggered, and output current will be the current through the T_1 i.e., i_{T1}.

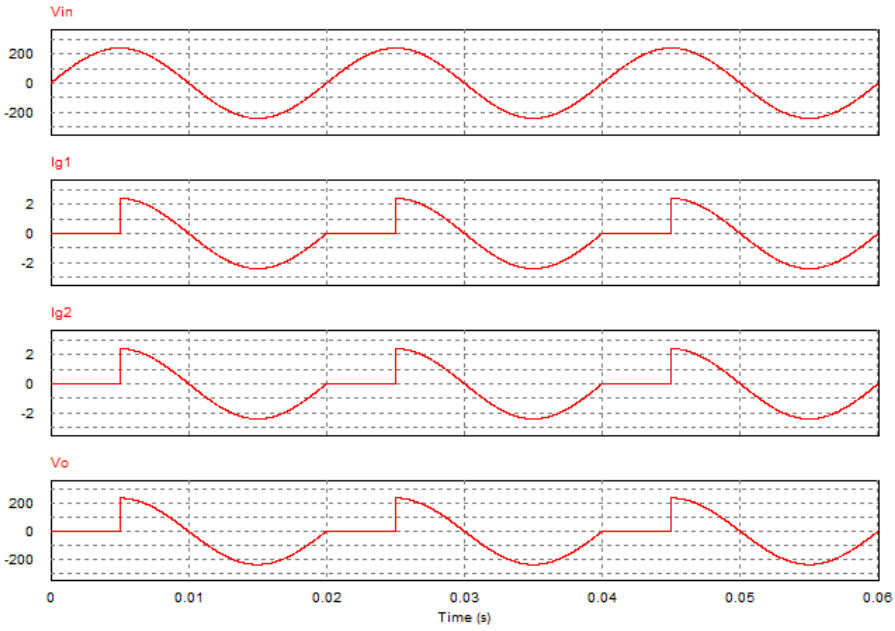


Waveforms for Single Phase AC Voltage Controller With RL Load When $\alpha > \phi$

- **With R load :**

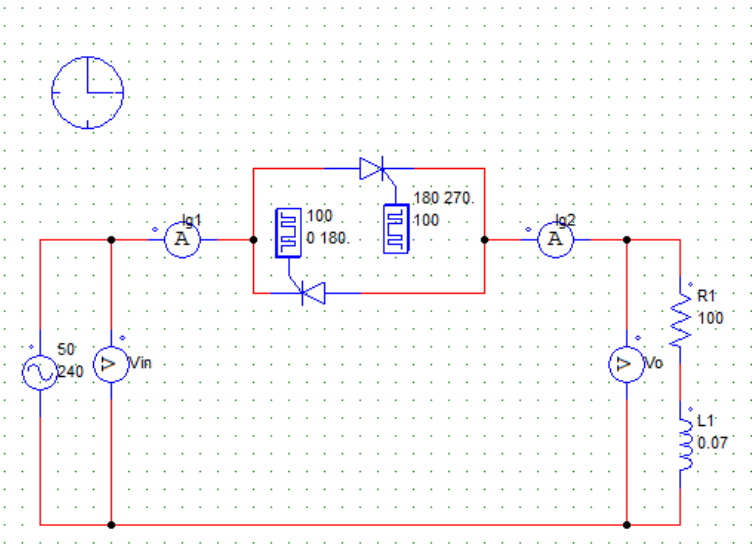


Circuit Diagram

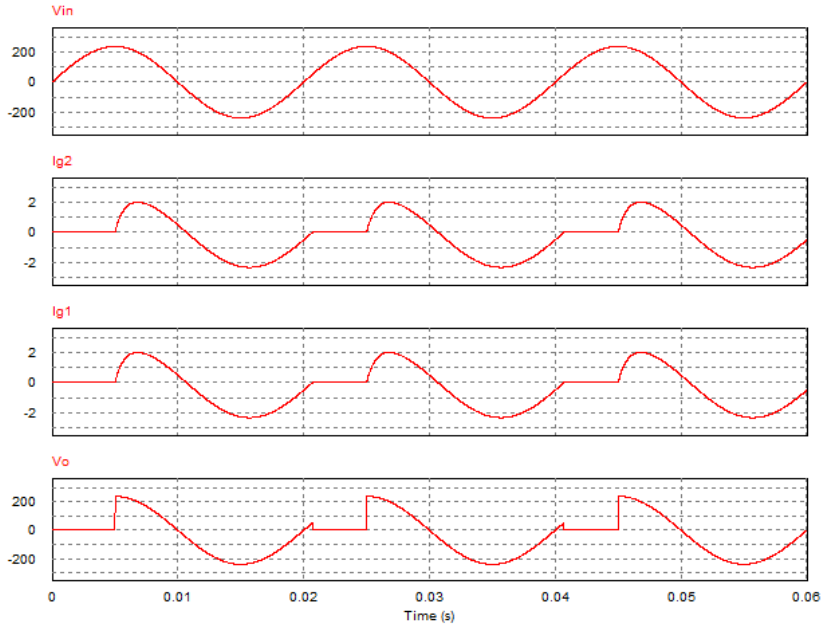


Output Waveform

- **With RL load :**



Circuit Diagram



Output Waveform

- ## CONCLUSION:

In this experiment AC voltage controller using SCRs in anti-parallel connection (TRIAC) was constructed with R and RL load and the performance was also analysed. AC voltage controllers are employed to vary the RMS value of the alternating voltage applied to a load circuit by introducing thyristors 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 thyristors in the ac voltage controller circuits.

Date: 05/04/22

EXPERIMENT NO: 06

DESIGN OF 3 PHASE VOLTAGE SOURCE INVERTER.

- OBJECTIVE : To design and simulate a 3 phase voltage source inverter using MATLAB SIMULINK.

- THEORY :

In electrical engineering inverters are one of the basic circuits used and are mostly used in UPS(Uninterrupted Power Supply) which is present in almost every house now a day. The basic purpose of an inverter is to convert the Direct Current (DC) to alternating current (AC), which is no doubt the opposite of rectifiers. For the beginners, the definition of AC voltage can be taken as the voltage which changes its direction from positive voltage to negative across same terminal in a specified period of time over and over again. A simple sinusoidal wave is an AC wave. However, DC can be defined as a constant source of voltage which remains either positive or negative through the course of time.

Types of Inverters

Inverters can be classified into two major types :

- **Single phase inverter**

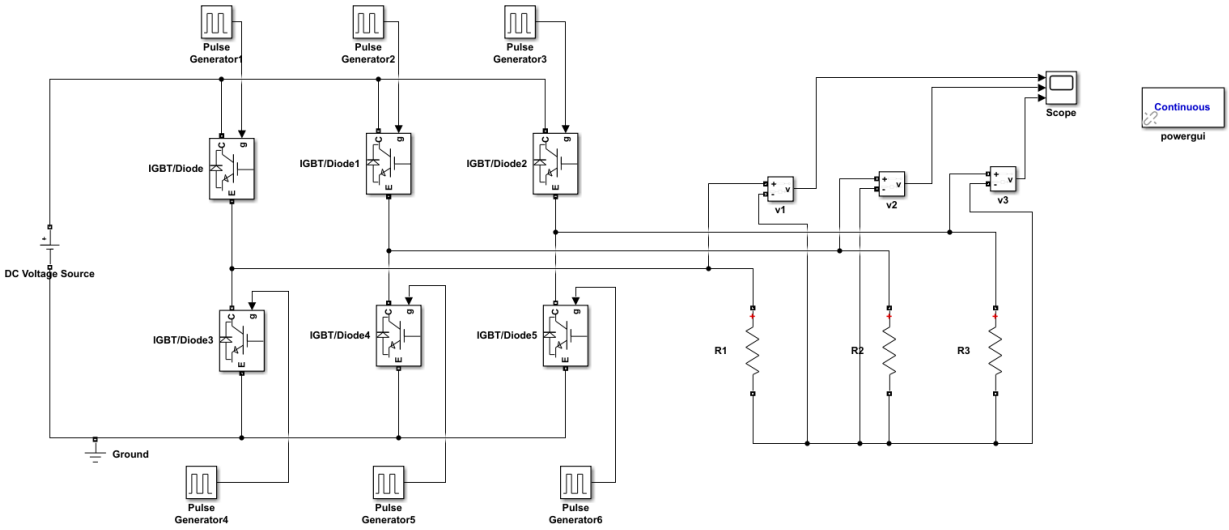
Single phase inverter is the type of inverter in which only one DC source is used and the output thus formed is a single phase AC waveform. In the circuit, a bridge like circuit comprised of IGBT transistor is used which converts DC to AC

- **3 phase inverter**

Alternatively, a three phase inverter uses two input DC sources, using 6 IGBT transistors to convert DC voltage into AC voltage and the output of such a circuit will be a three phase AC waveform with a

phase difference of 120 . In the explanation below, we will design a three phase inverter in Simulink.

- ## CIRCUIT DIAGRAM:-



- ## PROCEDURE:-

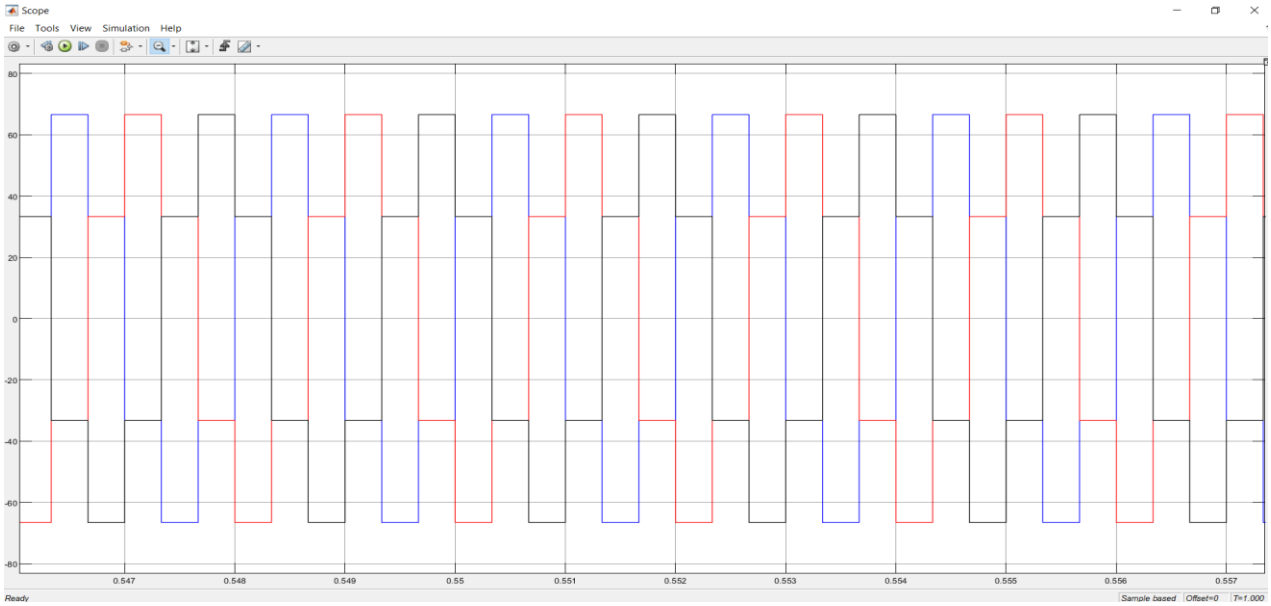
1) Open the MATLAB Simulink software and construct the circuit of the inverter.

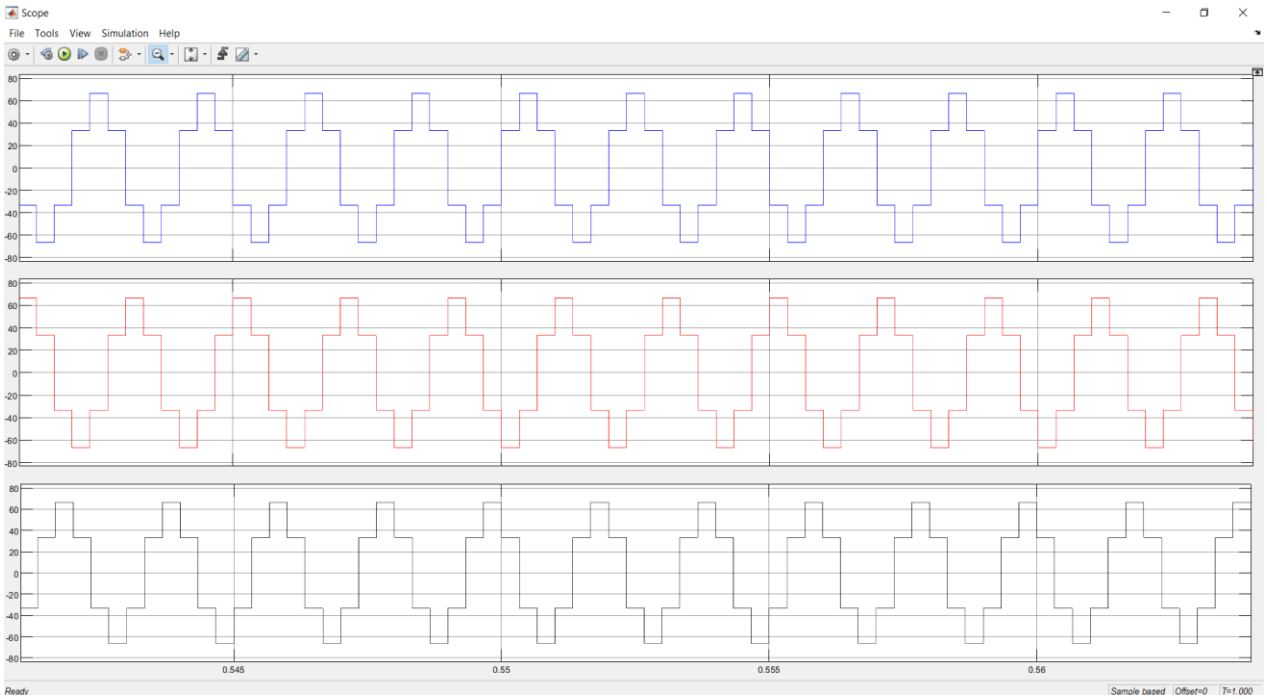
2) Use the “Library Browser” icon to get all the relevant components or devices.

3) Reset the parameters of different devices by double clicking over them.

4) Then click “run simulation” for simulation process and observe the output graph through the Scope.

- **OUTPUT WAVEFORM:-**





- **CONCLUSION:**

In this experiment, we had learned how to design and simulate three phase voltage source inverter using Simulink MATLAB, the working of inverters, more specifically 3 phase inverters. Inverters are one of the very basic circuits of electronics, also known as the opposite of rectifiers.

Date: 05/04/22

EXPERIMENT NO: 07

3 PHASE VOLTAGE SOURCE INVERTER FED INDUCTION MOTOR DESIGN AND SIMULATION.

- OBJECTIVE: To study 3 phase voltage source inverter fed Induction motor drive analysis using MATLAB Simulink.

- THEORY:

Voltage source inverter gives a variable frequency supply from a constant dc supply. The schematic diagram of a VSI fed induction motor drive using transistor is shown in below. Any other self-commutated device can be used instead of transistor. Generally MOSFET is used in low voltage and low power inverters, IGBT and power transistors are used up to medium power levels and GTO and IGCT are used for high power levels.

VSI can be operated as a stepped wave inverter or a pulse width modulated (PWM) inverter. When operated as a stepped wave inverter, transistors are switched in the sequence of their numbers with a time difference of T/6 and each transistor is kept on for the duration of T/2, where T is the time period of one cycle. Resultant line voltage waveform is shown in fig. Frequency of the inverter operation is varied by varying T and the output voltage of inverter is varied by varying dc input voltage.

The various VSI controlled IM drive is shown below.

- When supply is dc, variable dc input voltage is obtained by connecting chopper between dc supply and inverter.
- When supply is fixed dc, PWM inverter is used.

- When supply is ac, variable dc input voltage is obtained by connecting a controlled rectifier or diode bridge rectifier between ac supply and inverter.

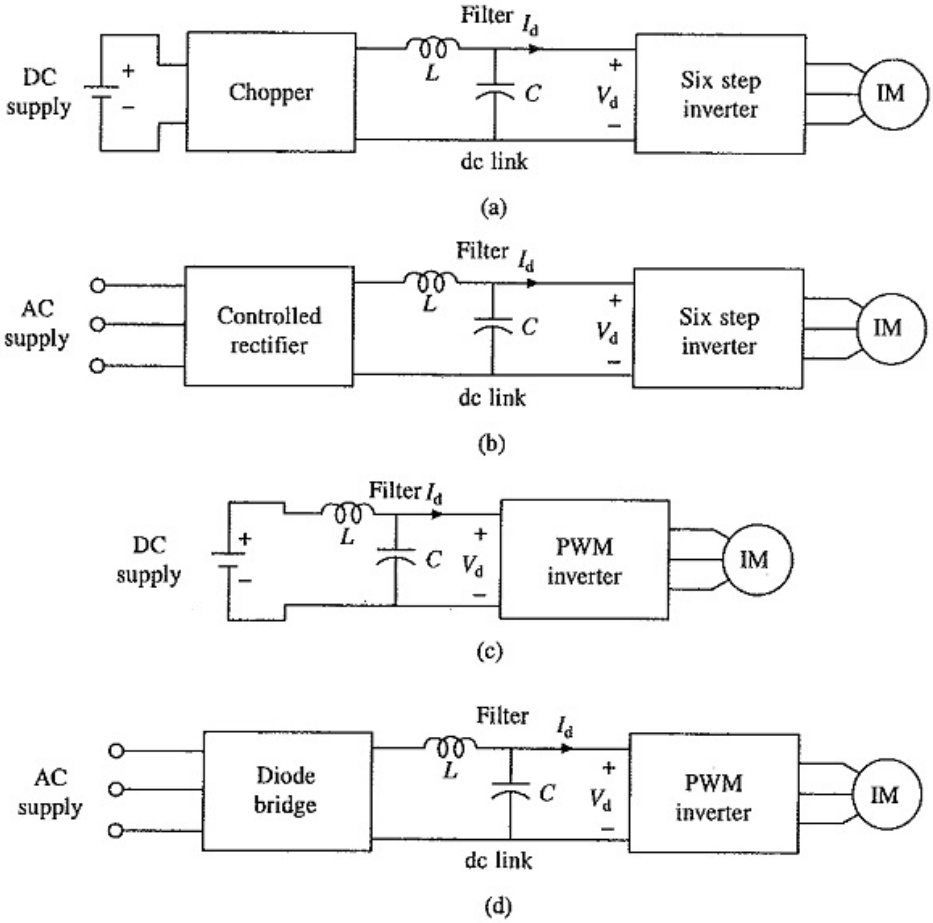
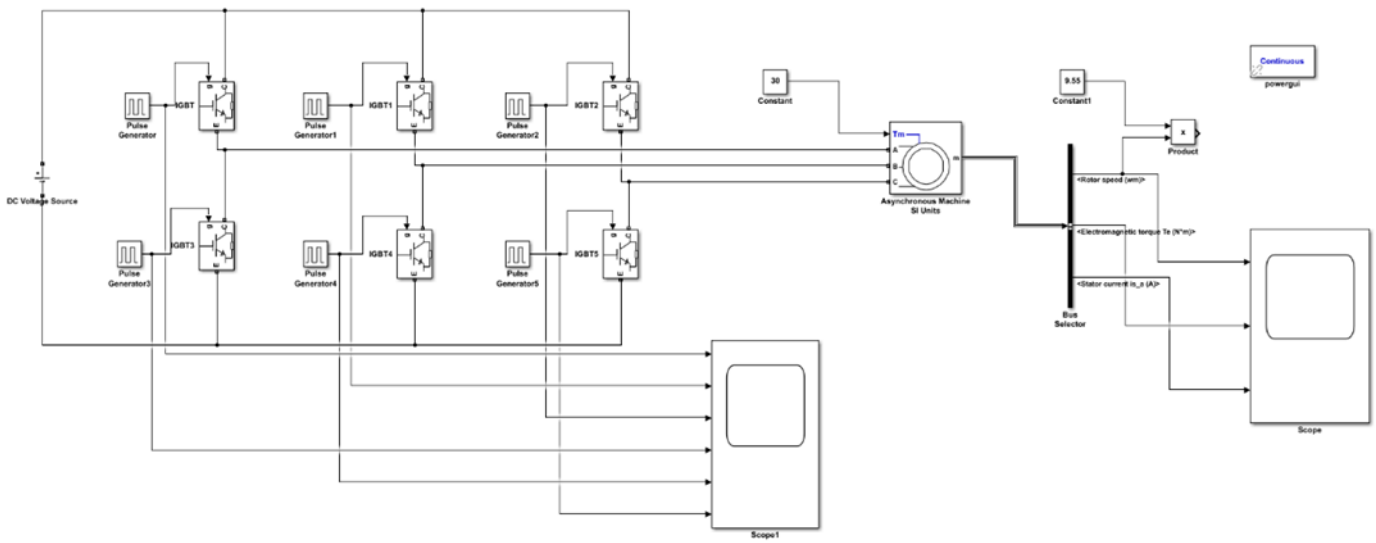


Fig. 6.38 VSI controlled IM drives

- CIRCUIT DIAGRAM:-



- ## PROCEDURE:-

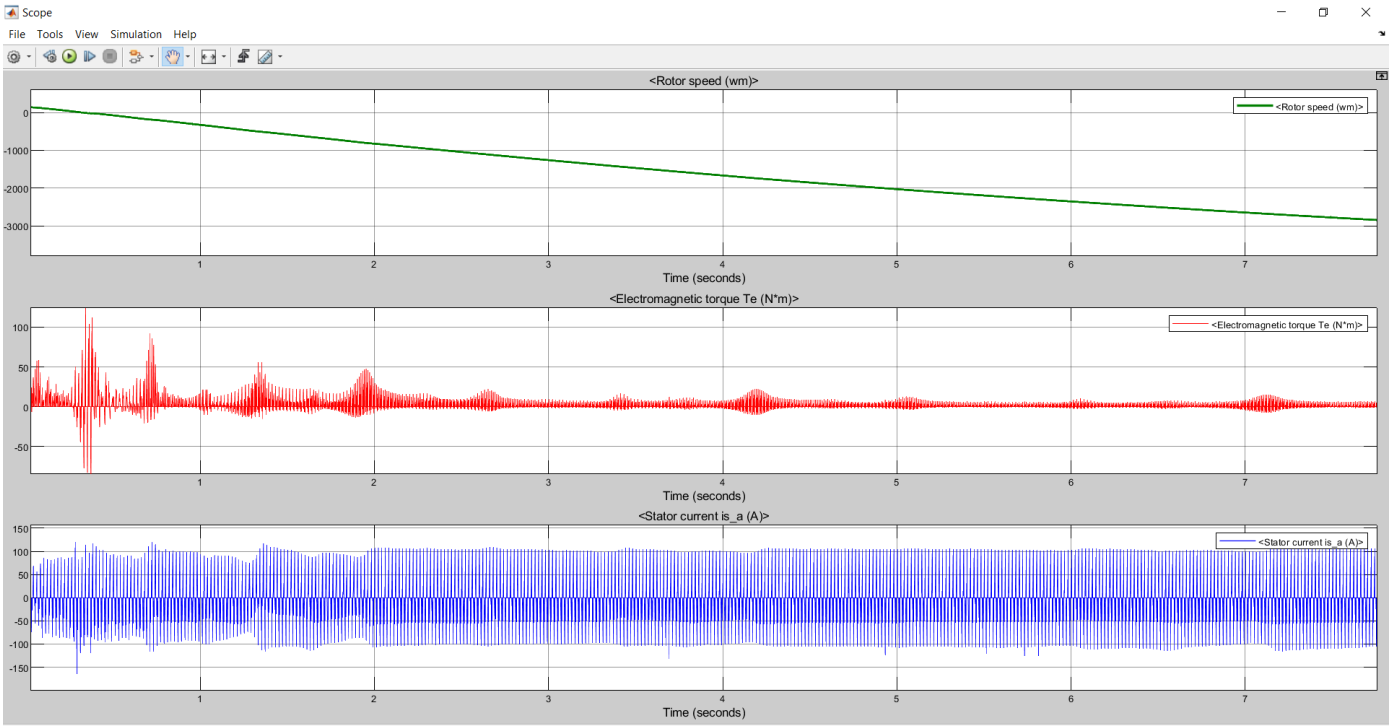
1) Open the MATLAB Simulink software and construct the circuit of the inverter.

2) Use the “Library Browser” icon to get all the relevant components or devices.

3) Reset the parameters of different devices by double clicking over them.

4) Then click “run simulation” for simulation process and observe the output graph through the Scope.

Input Waveform



Output Waveform

- CONCLUSION:

In this experiment we have designed Voltage source inverter fed induction motor drive by using MATLAB Simulink. Voltage source inverter can be used to control the stator terminal voltage by controlling duty ratio of the switches. Hence stator terminal voltage is varied and results in speed variation of the motor. By properly controlling duty ratio desired speed range can be achieved in the motor.

Date: 17/05/22

EXPERIMENT NO: 08

SIMULATION OF SINGLE PHASE INVERTER FED MOTOR DRIVE USING PSIM.

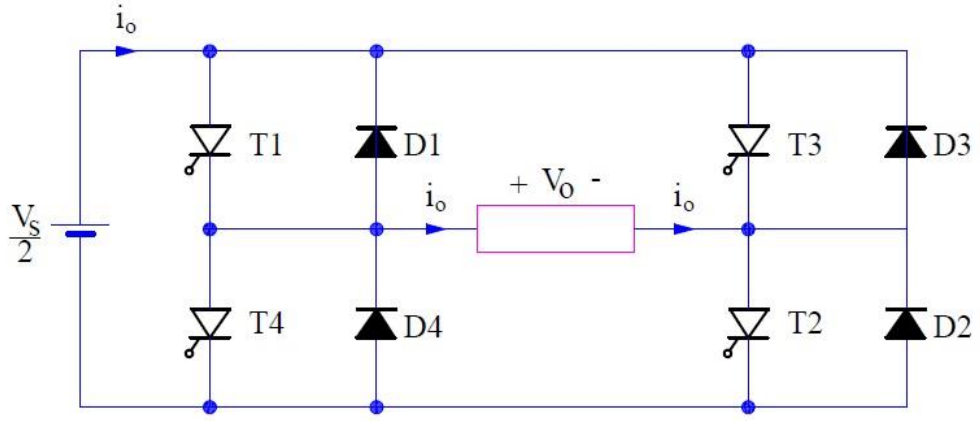
- OBJECTIVE : To study and simulate a single phase inverter fed motor drive using PSIM software.

- SOFTWARE USED: PSIM2021a

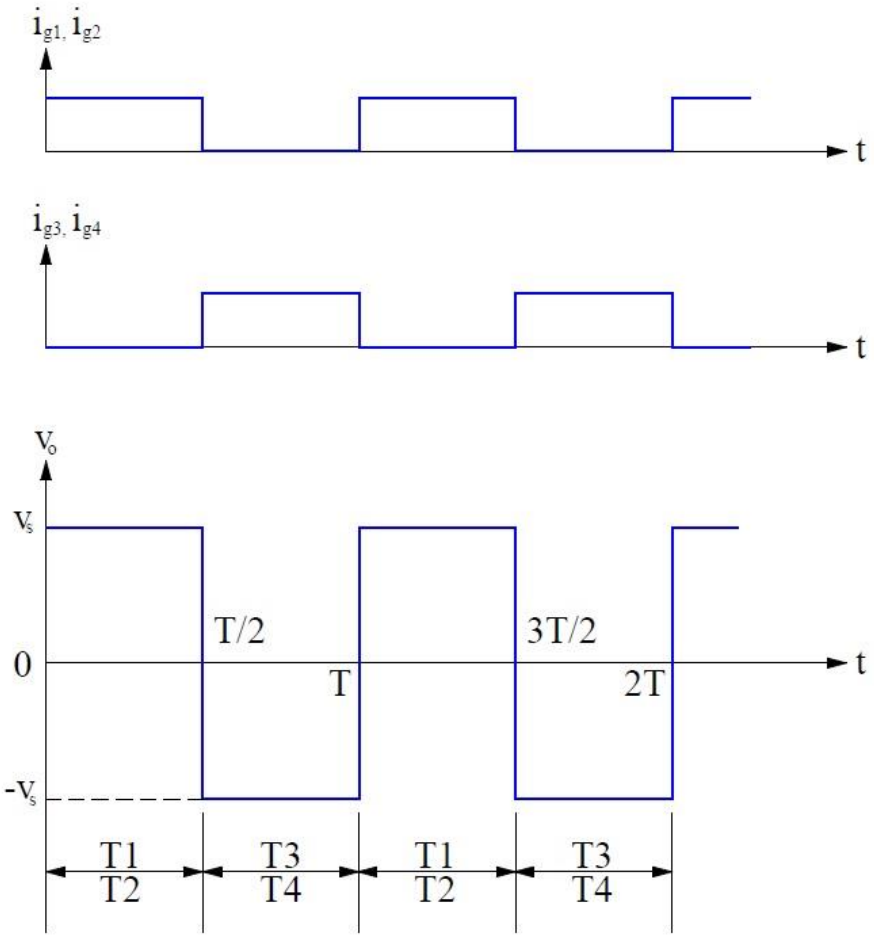
- THEORY:

Single Phase Full Bridge Inverter is basically a voltage source inverter. Unlike Single Phase Half Bridge Inverter, this inverter does not require three wire DC input supply. Rather, two wire DC input power source suffices the requirement. The output frequency can be controlled by controlling the turn ON and turn OFF time of the thyristors.

The power circuit of a single phase full bridge inverter comprises of four thyristors T1 to T4, four diodes D1 to D1 and a two wire DC input power source Vs. Each diode is connected in antiparallel to the thyristors. D1 is connected in anti-parallel to T1 and so on. The power circuit diagram of a single phase full bridge inverter is shown in the figure below.



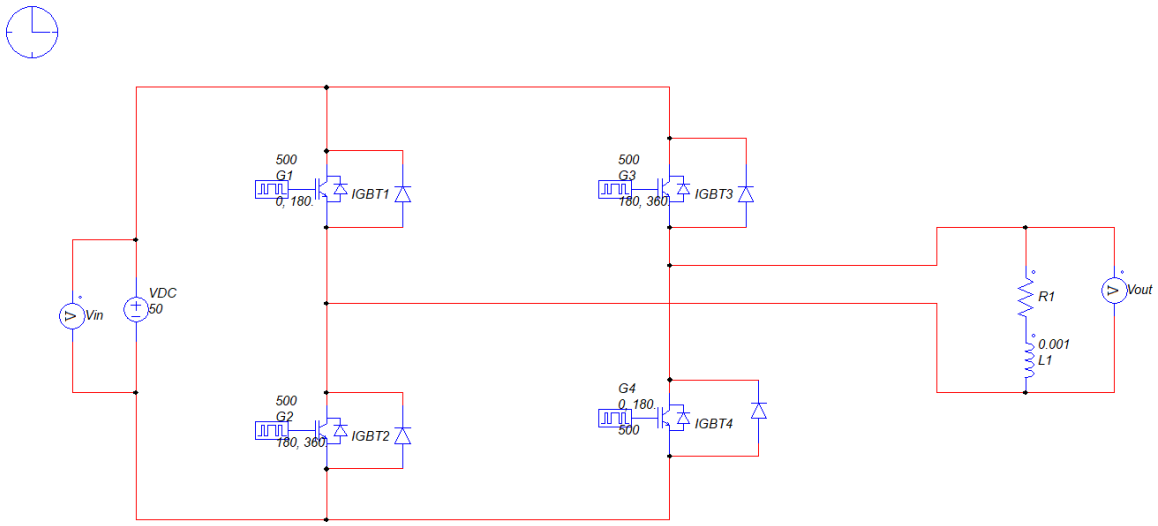
It may be noted that the circuitry for turning ON and turning OFF the thyristor is not shown in the above circuit diagram to maintain simplicity. Further, it is assumed that each of the thyristor only conducts for the period its gate signal is present and as soon as the gate signal is removed, the thyristors gets turned OFF.
The gating signal and output voltage waveform of a single phase full bridge inverter is shown below.



Working Principle of Single Phase Full Bridge Inverter:
The working principle of single phase full bridge inverter is based on the sequential triggering of thyristors placed diagonally opposite. This means, for half of time period, thyristors T3 & T4 will be triggered while for the remaining half of time period, T1 & T2 will be triggered. Only two thyristors are turned ON in half of the time period. Carefully observe the waveform of the gating signal. You will notice that thyristors T1 & T2 are triggered simultaneously for a time T/2. Therefore, load is connected to source through T1 & T2 and

hence, the load voltage is equal to the source voltage with positive polarity. This is the reason; the load voltage is shown positive & equal to Vs in the output voltage waveform.

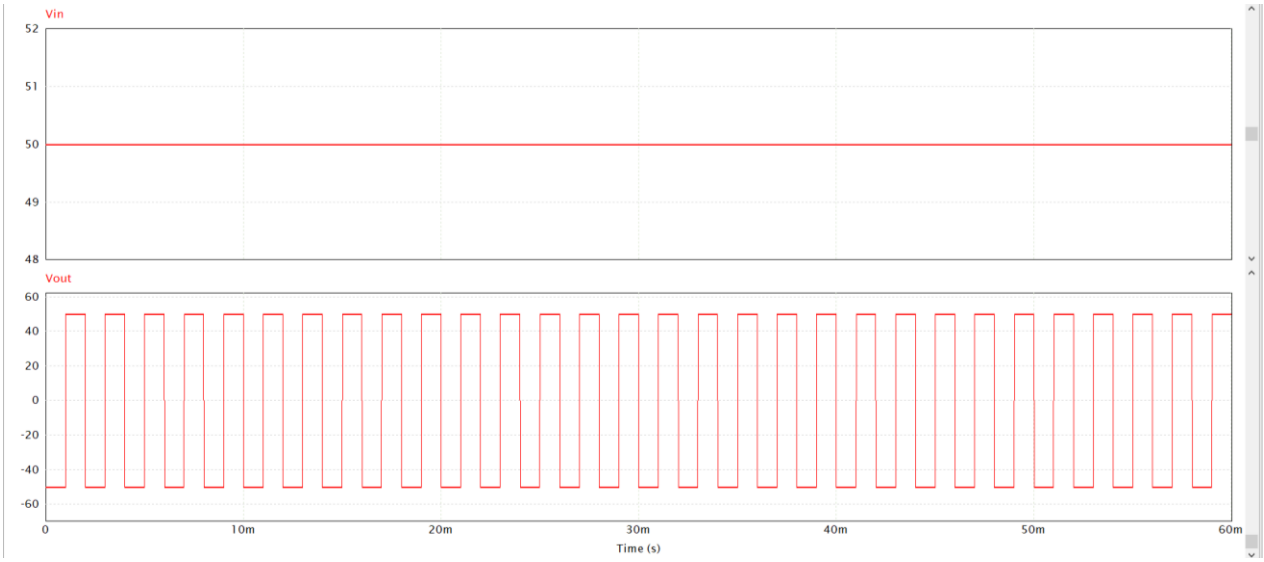
- **CIRCUIT DIAGRAM:-**



- **PROCEDURE:**

- Open the PSIM software and connect the circuit as per circuit diagram.
- Use the “element” icon to get all the relevant components or devices.
- Reset the parameters of different devices by double clicking over the element.
- Connect voltmeter as shown in the fig.
- Now click ‘simulation control’ icon for transient analysis
- Then click “run simulation” for simulation process. Graphical window will appear.
- Observe the waveforms of the following: Input voltage (Vin), Output Voltage (Vout).

- ## OUTPUT GRAPH:



- ## CONCLUSION:

In this experiment we have designed a single phase full bridge inverter using PSIM software. It converters fixed DC voltage into variable AC voltage. Here the circuit consists of SCRs. By varying the SCR firing angle the output voltage can be controlled. This variable output voltage is fed to the motor drive. By varying the motor input voltage the motor speed can be controlled.