Course Name:	**Power Electronics**	**Semester:**	**VI**
Date of Performance:	**25.03.2022**	**Batch No:**	**B1**
Faculty Name:	**Prof. Sandeep Hanumante**	**Roll No:**	**1912052**
Faculty Sign & Date:		**Grade/Marks:**	

Experiment No: 9

Title: **Simulation of three phase Inverter**

Aim and Objective of the Experiment:

- Simulation of three Phase Half and Full Bridge Voltage Source Inverter with R and RL load.

COs to be achieved:

CO3

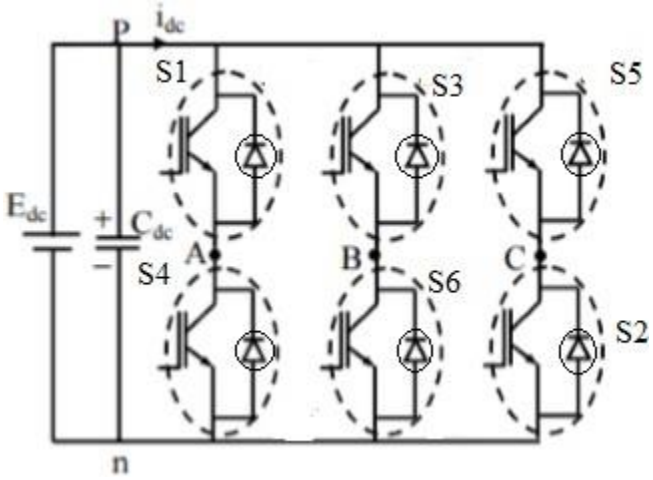
Theory:

Three Phase Inverter Design/Circuit Diagram

The circuit diagram of a three-phase inverter is shown below. The main function of this kind of inverter is to change the input of DC to the output of three-phase AC. A basic 3 phase inverter includes 3 single phase inverter switches where each switch can be connected to one of the 3 load terminals.

Generally, the three arms of this inverter will be delayed with 120 degrees angle to generate a 3 phase AC supply.

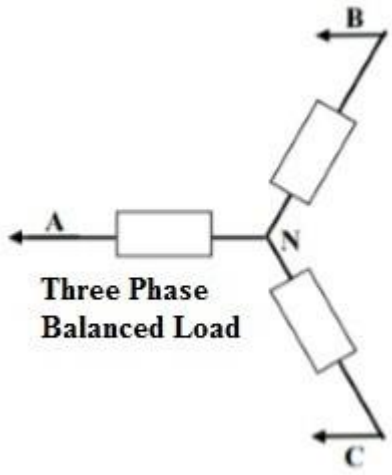
The switches used in the inverter have 50% of ratio and switching can occur after every 60 degrees angle. The switches like S1, S2, S3, S4, S5, and S6 will complement each other. In this, three inverters with single-phase are placed across a similar DC source. The pole voltages within the three-phase inverter are equivalent to the pole voltages within the half-bridge inverter with a single phase.



The two types of inverters like the single-phase and three-phase include two conduction modes like 180 degrees conduction mode and 120 degrees conduction mode.

180° Conduction Mode

In this conduction mode, each device will be in conduction with 180° where they are activated at intervals with 60°. The output terminals like A, B, and C are connected to the star or 3 phase delta connection of the load.



The balanced load for three phases is explained in the following diagram. For 0 to 60 degrees, the switches like S1, S5 & S6 are in conduction mode. The load terminals like A & C are linked to the source on its positive point, whereas the B terminal is associated with the source on its negative point. Furthermore, the R/2 resistance is available among the two ends of neutral & the positive whereas R resistance is available among the neutral & the negative terminal.

In this mode, the voltages of load are given in the following.

VAN = V/3
VBN = −2V/3,
VCN = V/3

The line voltages are given in the following.

$V_{AB} = V_{AN} - V_{BN} = V$,

$V_{BC} = V_{BN} - V_{CN} = -V$,

$V_{CA} = V_{CN} - V_{AN} = 0$

120° Conduction Mode
In this type of conduction mode, every electronic device will be in a conduction state with 120°. It is apt for a delta connection within a load as it results within a six-step kind of waveform across one of its phases. So, at any instant, only these devices will conduct every device that will conduct at 120° only.

The connection of 'A' terminal on the load can be done through the positive end whereas the B terminal can be connected toward the negative terminal of the source. The 'C' terminal on the load will be in conduction is known as the floating state. Also, the phase voltages are equivalent to the voltages of load which is given below.

Phase voltages are equal to line voltages, so

$V_{AB} = V$

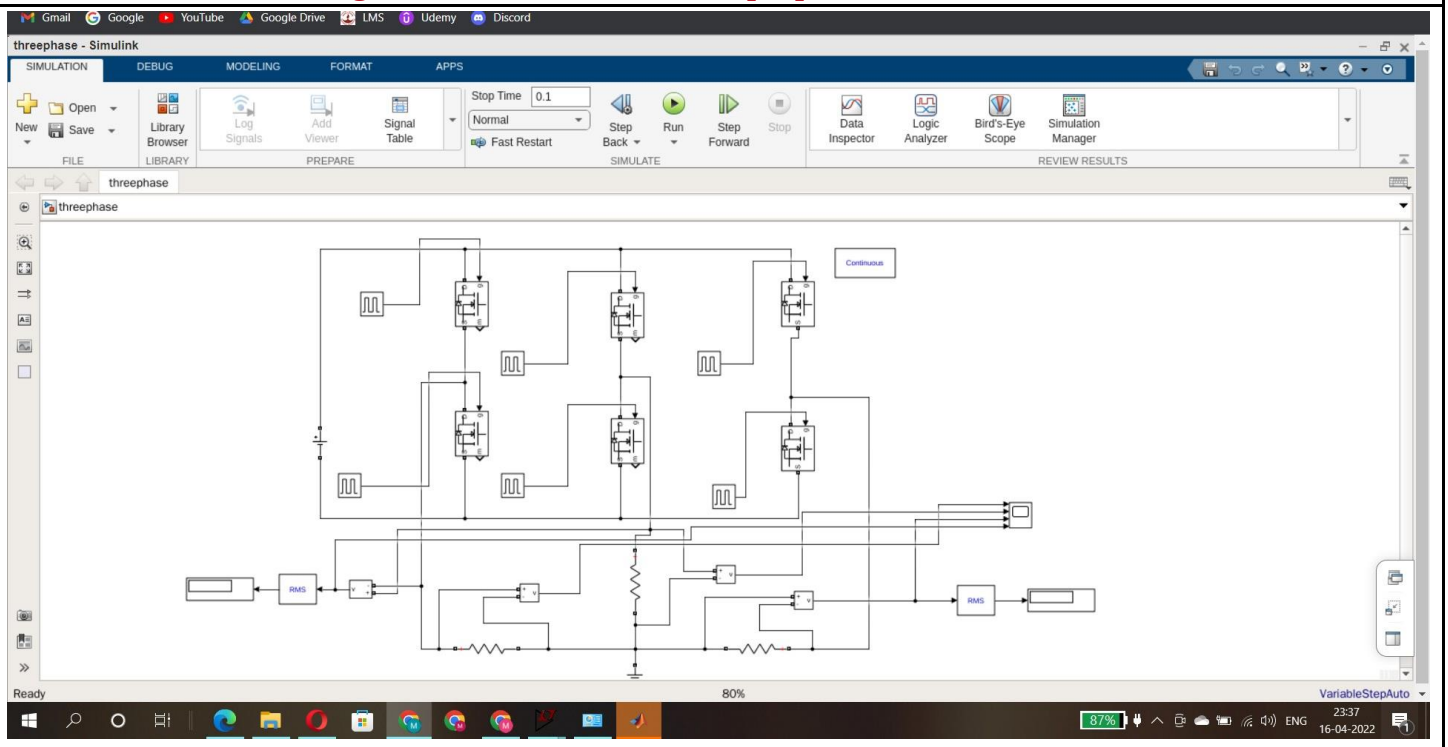
$V_{BC} = -V/2$

$V_{CA} = -V/2$

Three Phase Inverter Applications
The applications of this type of inverter include the following.

These inverters are utilized in variable frequency drive applications
Used in high-power applications like HVDC power transmission.
A three-phase square wave inverter is used in a UPS circuit and a low-cost solid-state frequency charger circuit.
Thus, this is all about an overview of a three-phase inverter, working principle, design or circuit diagram, conduction modes, and its applications. A 3 phase inverter is used to convert a DC i/p into an AC output. It includes three arms which are usually delayed through 120° of an angle to produce a 3 phase AC supply. The switches in an inverter have a 50% of ratio & switching happens after each T/6 of the time with 60° of angle interval.

Circuit or Simulation Diagram with values and device properties :

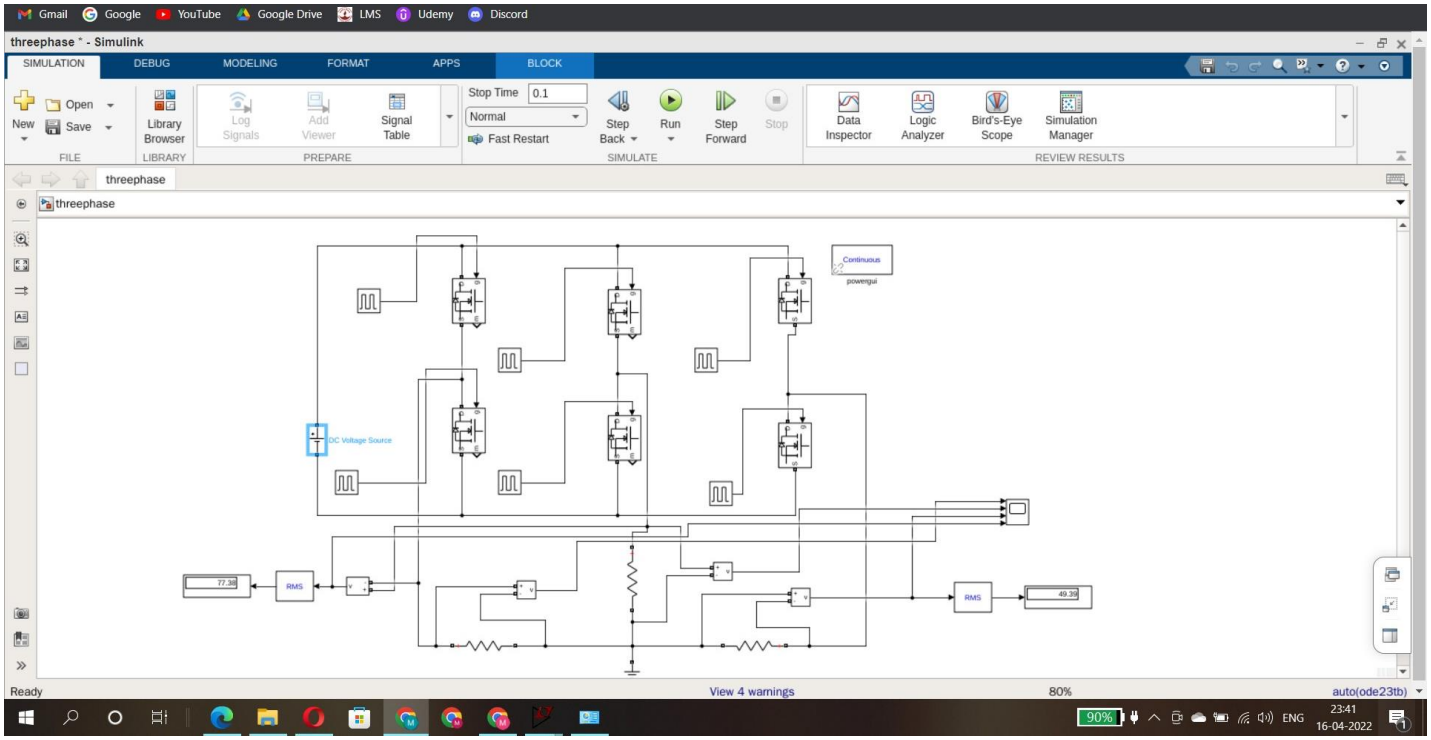


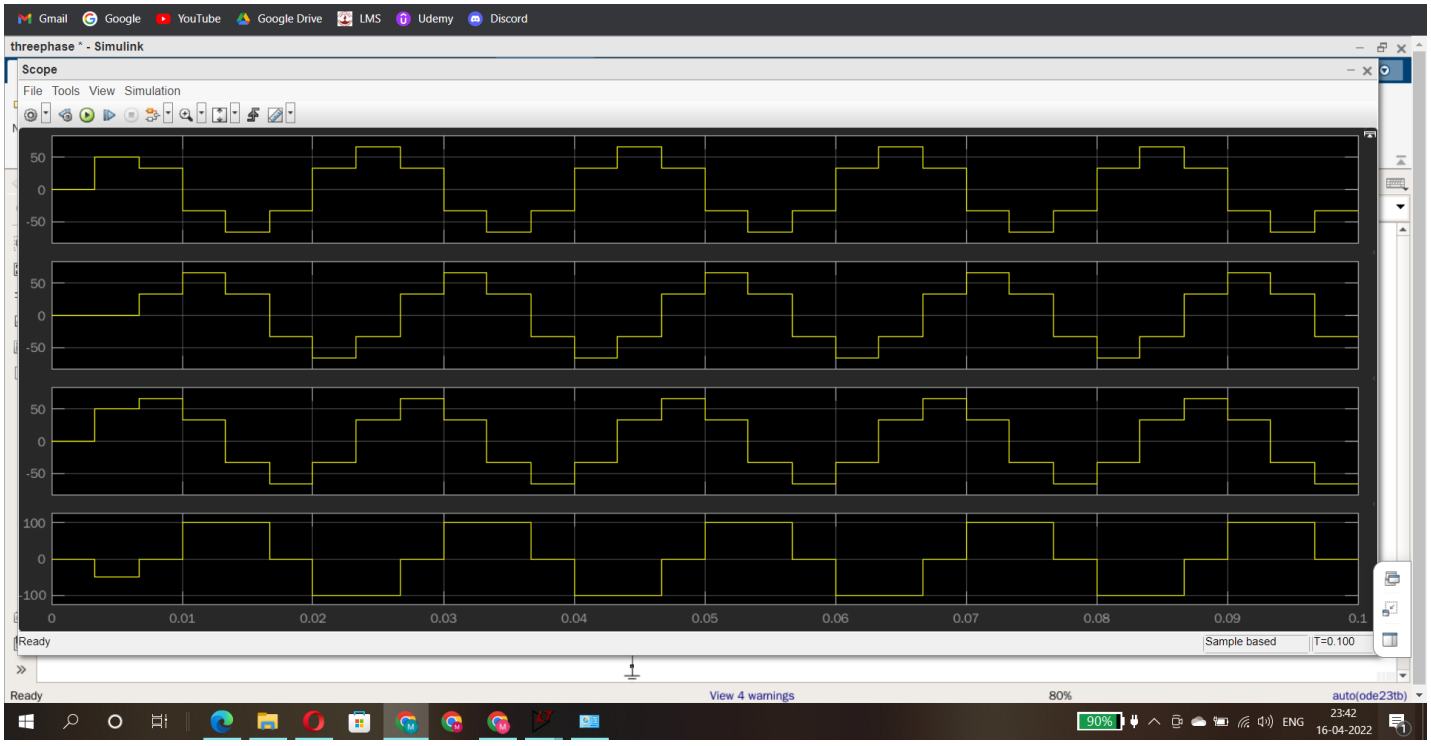
Simulation output snap shot:

Observation Table:

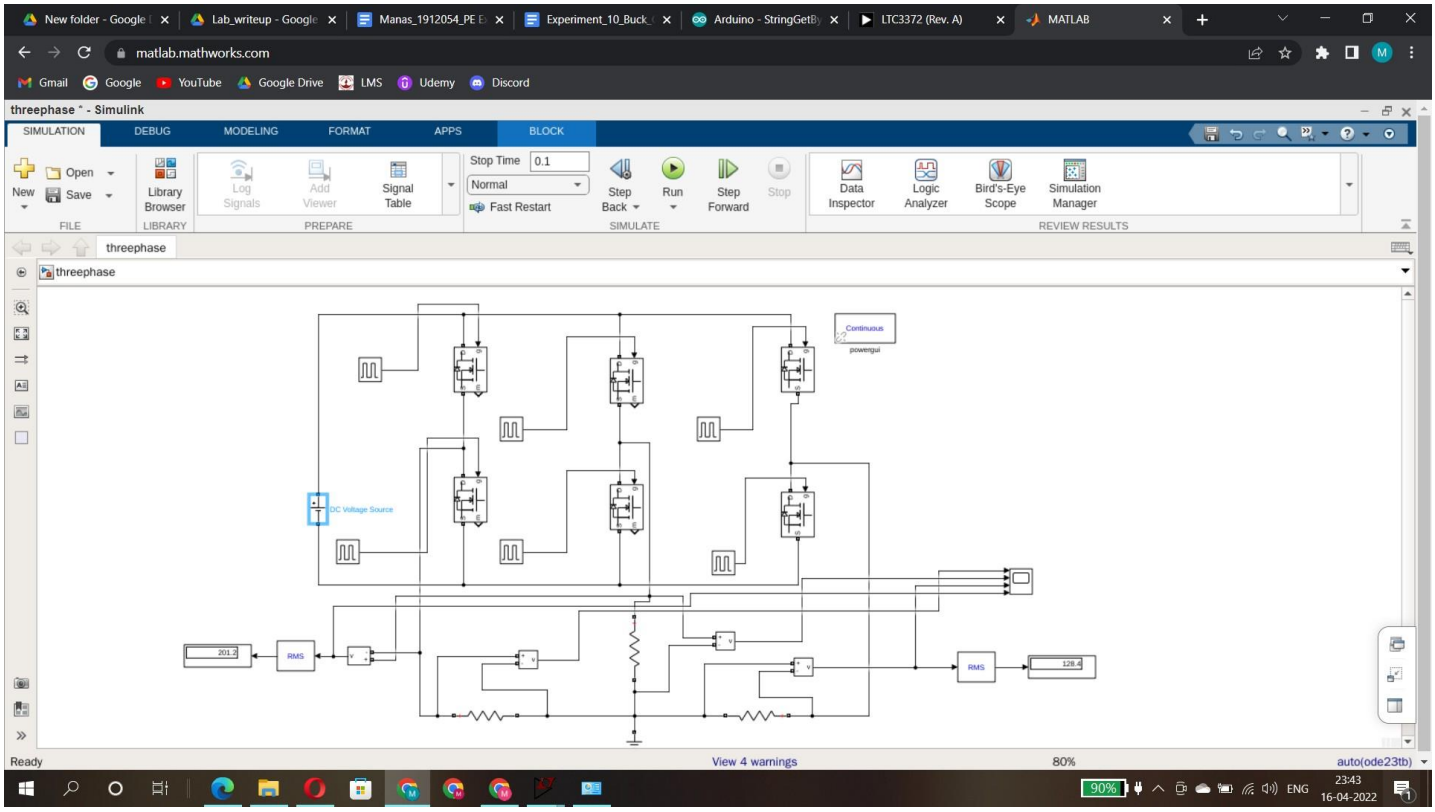
Sr No	VDC	VPH		VL	
		Theoretical	Practical	Theoretical	Practical
1	100	47	49.39	80	77.39
2	260	122.5	128.4	210	210.2
3	500	235.7	246.9	389.8	386.9

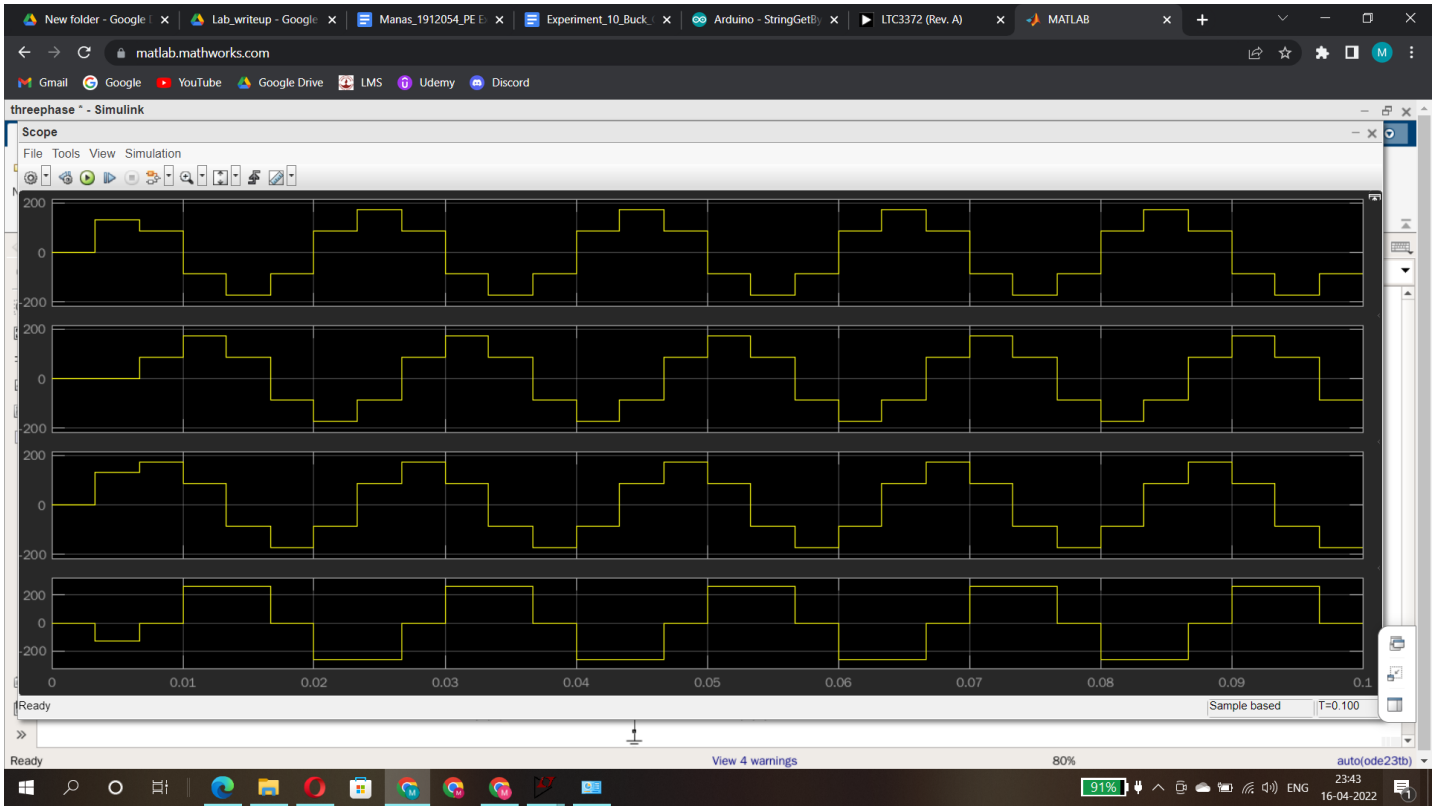
VDC = 100V


threephase * - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Stop Time 0.1
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
threephase
DC Voltage Source
RMS
77.38
49.39
Ready
View 4 warnings
80%
auto(ode23tb)

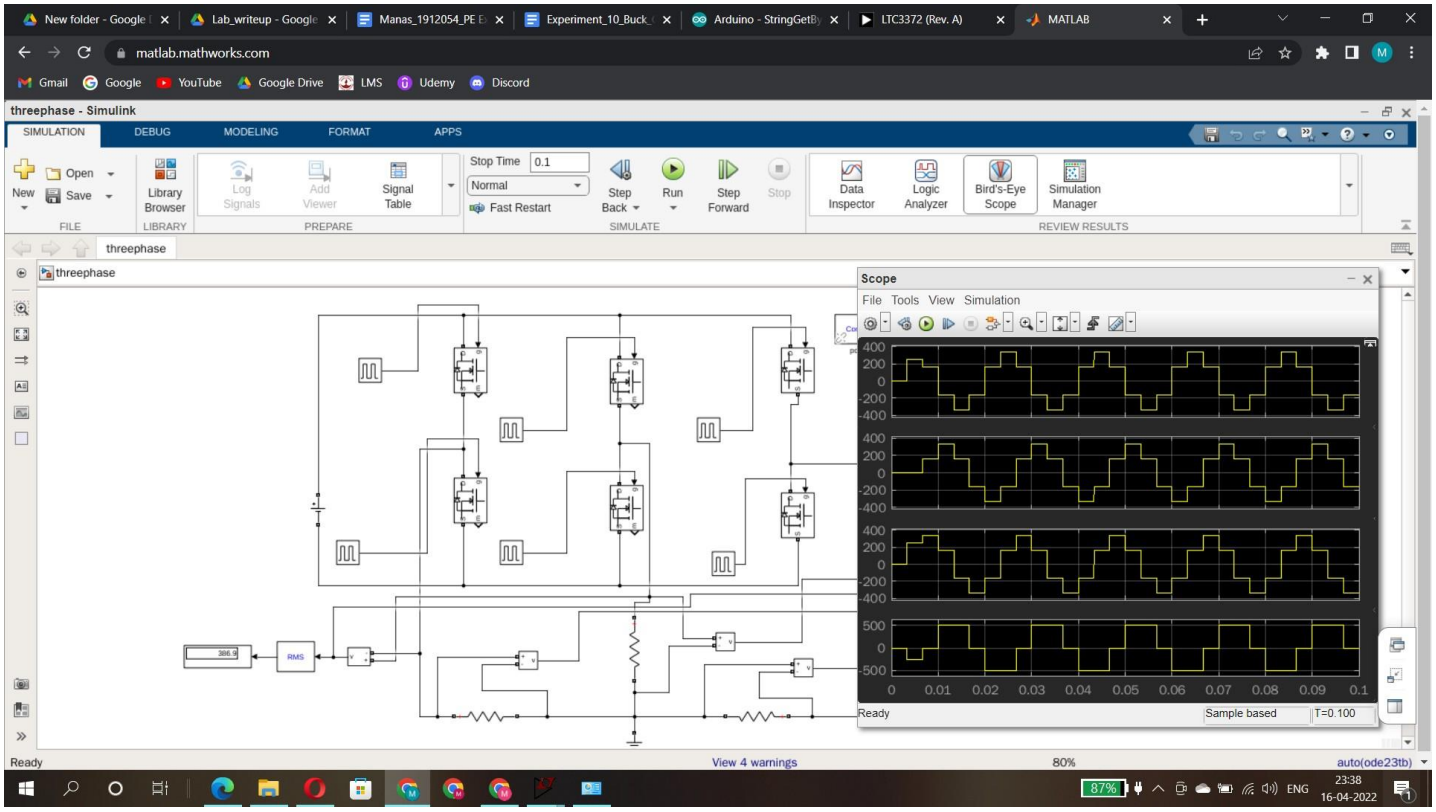

threephase * - Simulink
Scope
File Tools View Simulation
50
0
-50
100
-100
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Ready
Sample based
T=0.100
View 4 warnings
80%
auto(ode23tb)

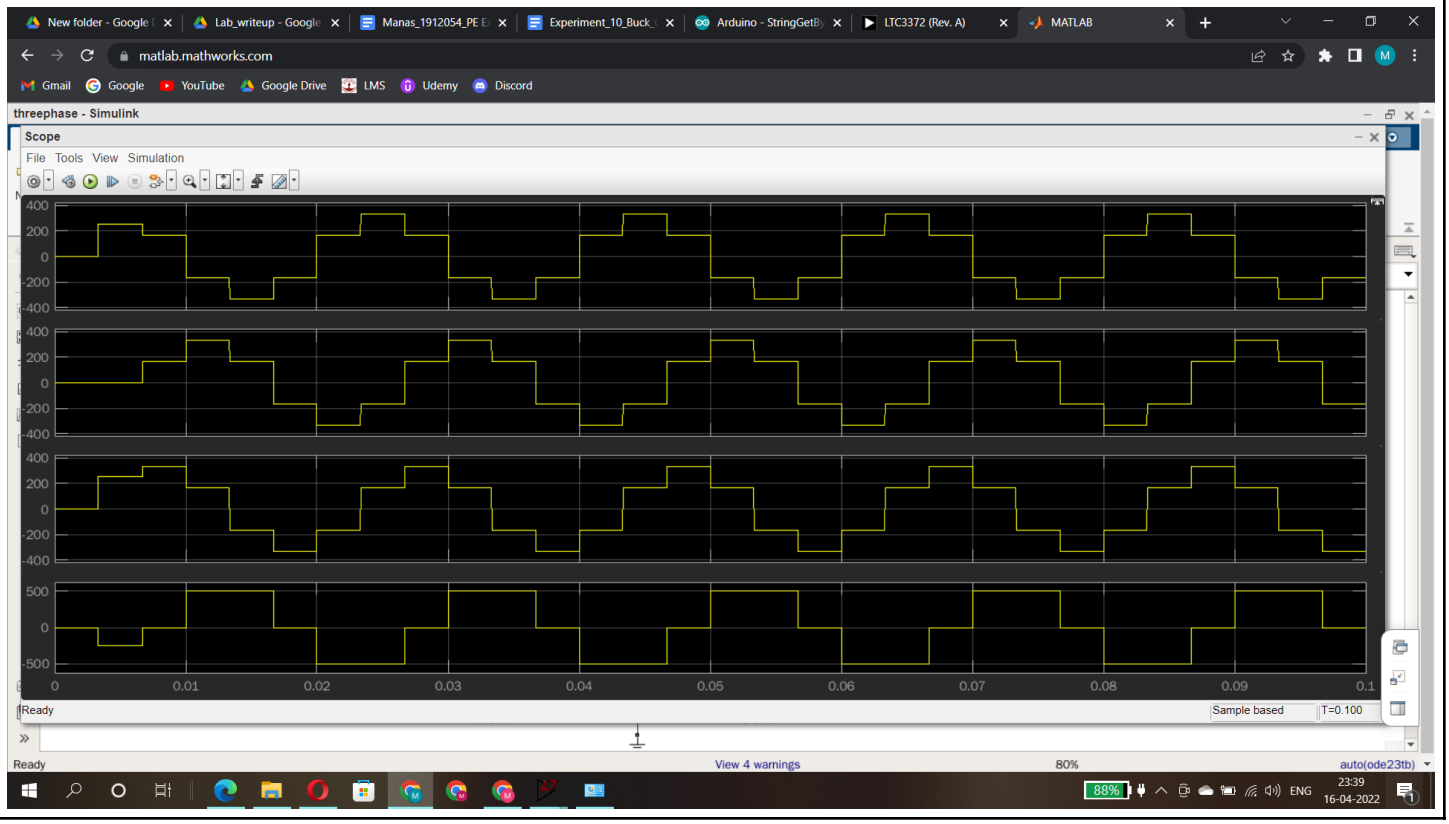
VDC = 260V


threephase ^ - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
BLOCK
Stop Time 0.1
Normal
Fast Restart
Step Back
Run
Step Forward
Stop
Data Inspector
Logic Analyzer
Bird's-Eye Scope
Simulation Manager
Library Browser
Signal Table
FILE
LIBRARY
PREPARE
SIMULATE
REVIEW RESULTS
threephase
DC Voltage Source
RMS
Ready
View 4 warnings
80%
auto(ode23tb)


threephase ^ - Simulink
Scope
File Tools View Simulation
200
0
-200
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
Ready
Sample based
T=0.100
Ready
View 4 warnings
80%
auto(ode23tb)

VDC = 500V


threephase - Simulink
Scope
File Tools View Simulation
Ready
Sample based
T=0.100
View 4 warnings
80%


threephase - Simulink
Scope
File Tools View Simulation
Ready
Sample based
T=0.100
View 4 warnings
80%

Stepwise-Procedure:

1. Decide component values and specifications of instruments used in the circuit and connect it as shown in the circuit diagram using PROTEUS or MATLAB SIMULINK.
2. Observe the output voltage and output current across the load for different values of R load and study the effect of variation in the load parameters.
3. In R-L load select inductance such that inductive reactance XL = 2×Π×f×L equal to R and observe output voltage and output current. Then make XL ≥ 5.R and observe output voltage and output current. Repeat the same with XL ≤ 5.R and observe output voltage and output current.

Observation /Output:

1. Attach the output waveforms got in the simulation for 3 Phase inverter for all types of R and R-L load.
2. Comment on change in output voltage and output current when inductor value is varied in R-L load.
3. Comment on how to change frequency and magnitude of output voltage and output current.

Post Lab Subjective/Objective type Questions:

1. **What is the expression for the rms load voltage for Half Bridge and Full Bridge VSI for R and R-L load?**
2. **What is the expression for the Fourier equation for load voltage for Half Bridge and Full Bridge VSI for R and R-L load? What will be the THD for both thetypes?/**
3. **How harmonics in Inverter can be reduced?**

Postlab:-

Q.1)

→ 1) RMS Load Voltage for Half Bridge Inverter with R and RL load:-

$$E_{o\,rms} = \frac{E_{dc}}{2}$$

2) RMS Load Voltage for Full Bridge Inverter with R-load and RL load:-

$$E_{o\,rms} = E_{dc}$$

Q.2)

→ Fourier Series:-

1) Half Bridge Inverter with R-load & RL load:-

$$e_o(\omega t) = \sum_{n=1,3,5}^{\infty} \frac{2E_{dc}}{n\pi} \sin(\omega t)$$

$$= 0 \quad \text{... for } n = 2, 4, 6, \ldots$$

2) Full Bridge Inverter with R-load & RL load:-

$$e_o(\omega t) = \sum_{n=1,3,5} \frac{4E_{dc}}{n\pi} \sin(\omega t)$$

$$= 0 \quad \text{... for } n = 2, 4, 6, \ldots$$

3) Total harmonic distortion (THD):-

$$THD = \sqrt{\frac{E_{o\,rms}^2 - E_1^2}{E_1}}$$

Q.3)

→ The harmonic content of the output voltage can be reduced by the output voltage from two or more inverters, can be combined by means of transformer. The essential condition of the scheme is that the output voltage waveform from inverter must be similar but phase shifted from each other.

Conclusion:

- **In this experiment, we learned about inverters and performed the simulation of the 3 phase inverter. We designed the circuit using the MATLAB SIMULINK.**
- **We obtained the output waveforms for the circuit. The waveforms verified the phasor diagrams of the 3 phase supply.**
- **Thus we understood the working of the 3 phase inverter and understood its applications.**

Signature of faculty in-charge with Date: