Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

Mathematical Modelling of Electrical and Electronic Systems

Week 4: Assignment

Task 1:

A 230 Volts, 50Hz, 3-Phase AC Supply has been connected to a Power Circuit Grid whose functionality is to be tested out. The voltage at the output of this Circuit Grid is approximately 400 Volts DC. The circuit is comprised of a combination of three power circuits. Design a model to simulate the task to achieve the target output.

Parameters:

1. Circuit 2: R= 3.6 Ohms, L= 2.2×10^{-6}, C= 2.2×10^{-6}, Switching Frequency = 2×10^{6} Hz.
2. Circuit 3: R= 26 Ohms, L= 0.64×10^{-3} H, C= 100×10^{-6} F, Switching Frequency = 50×10^{3} Hz.

Questions to be answered:

1. List down the converter circuits that are part of the Power Circuit Grid.

Ans: AC to DC converter, buck converter and boost converter.

2. In what sequence would the converter circuits be connected?

Ans: First AC to DC, second Buck converter, and then lastly Boost converter.

3. Which parameter should be modulated to obtain the desired output?

Ans: Duty Cycle.

4. Any alternative parameter(s) that can be modified to obtain an identical output?

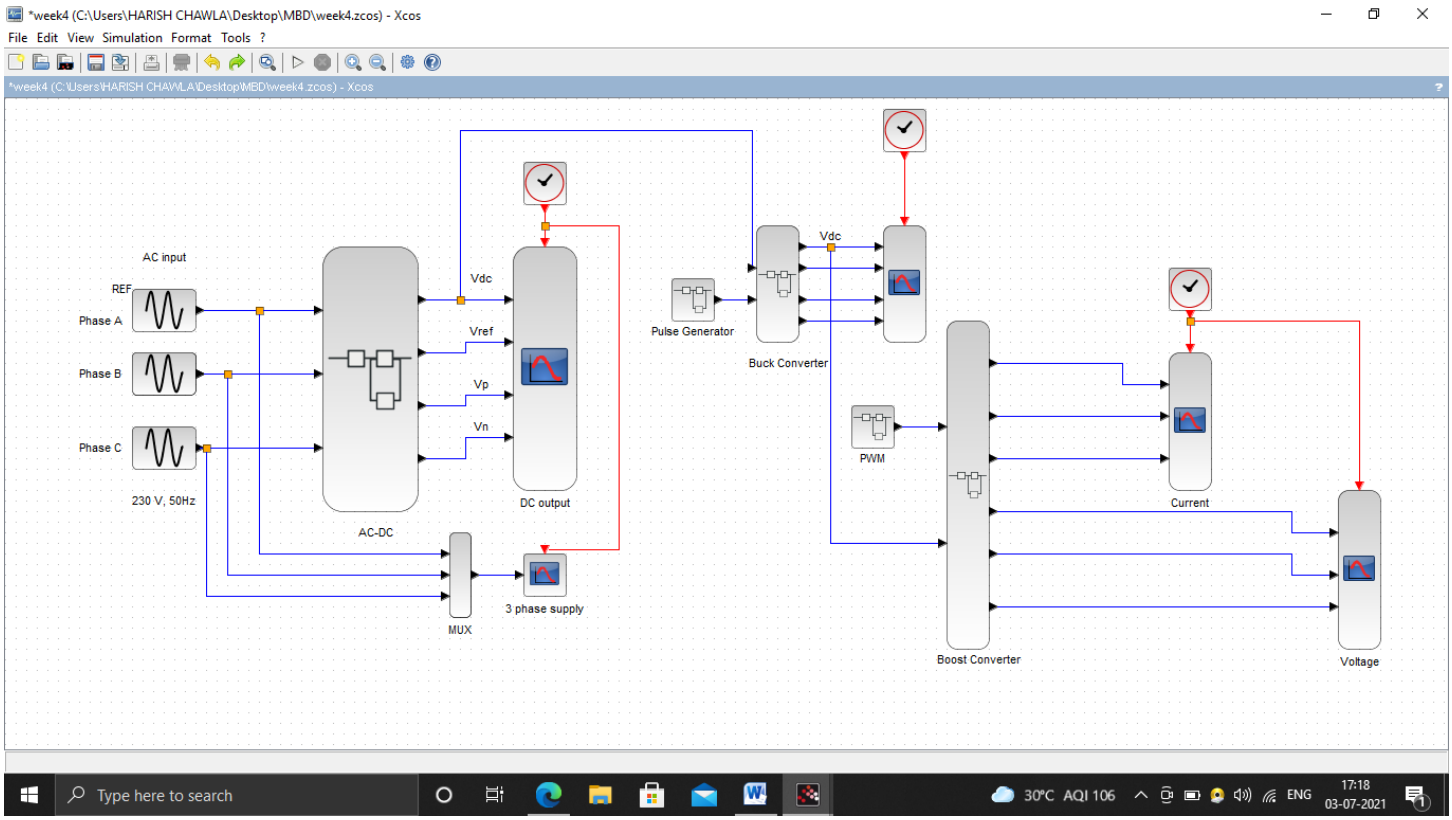
Ans: L and C parameters can be modified.

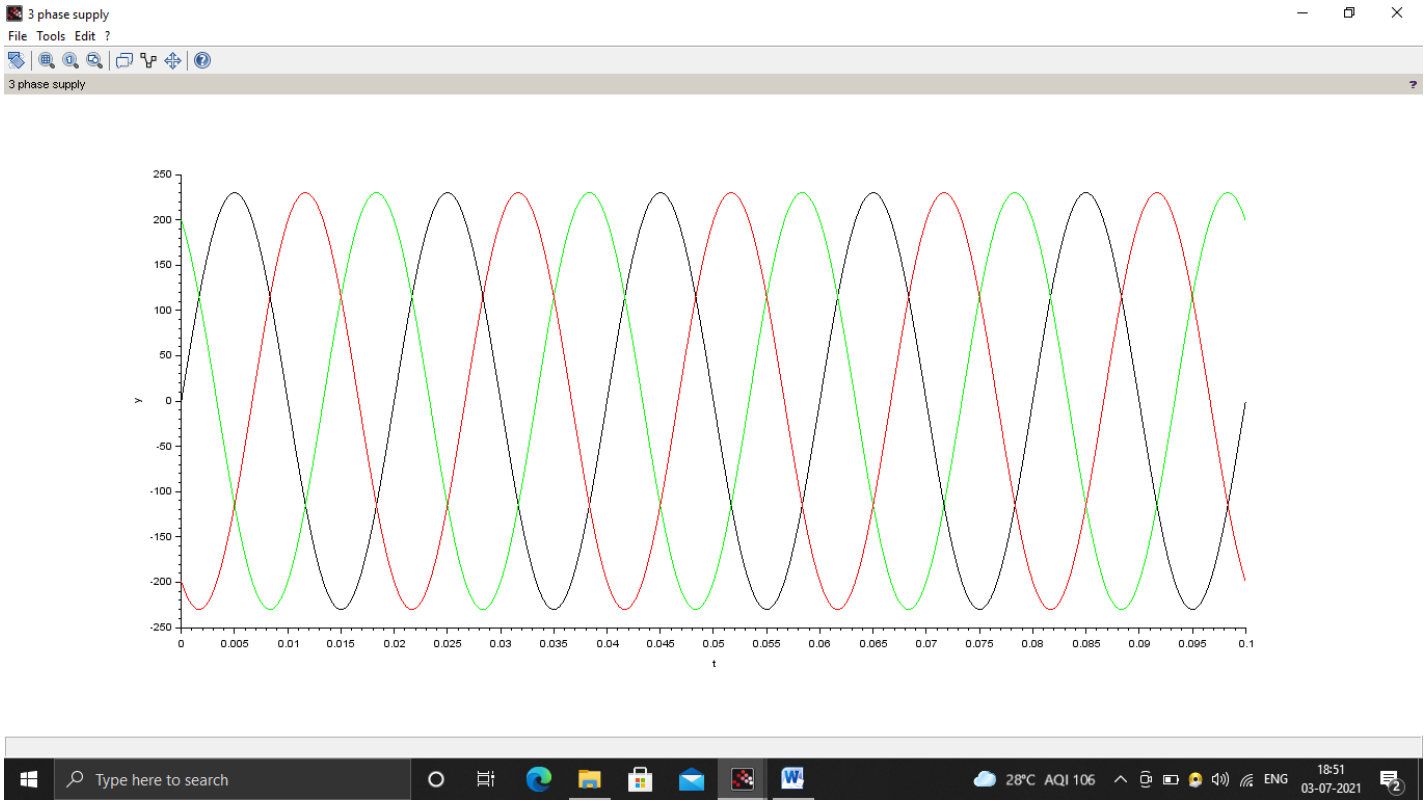
The following parameters are to be observed via the Scope:

1. Output Voltage
2. Intermediate Voltage
3. 3-phase Input Supply
4. Load Current (Circuit 2 and Circuit 3)
5. Inductor Current (Circuit 2 and Circuit 3)
6. PWM Signal(s).

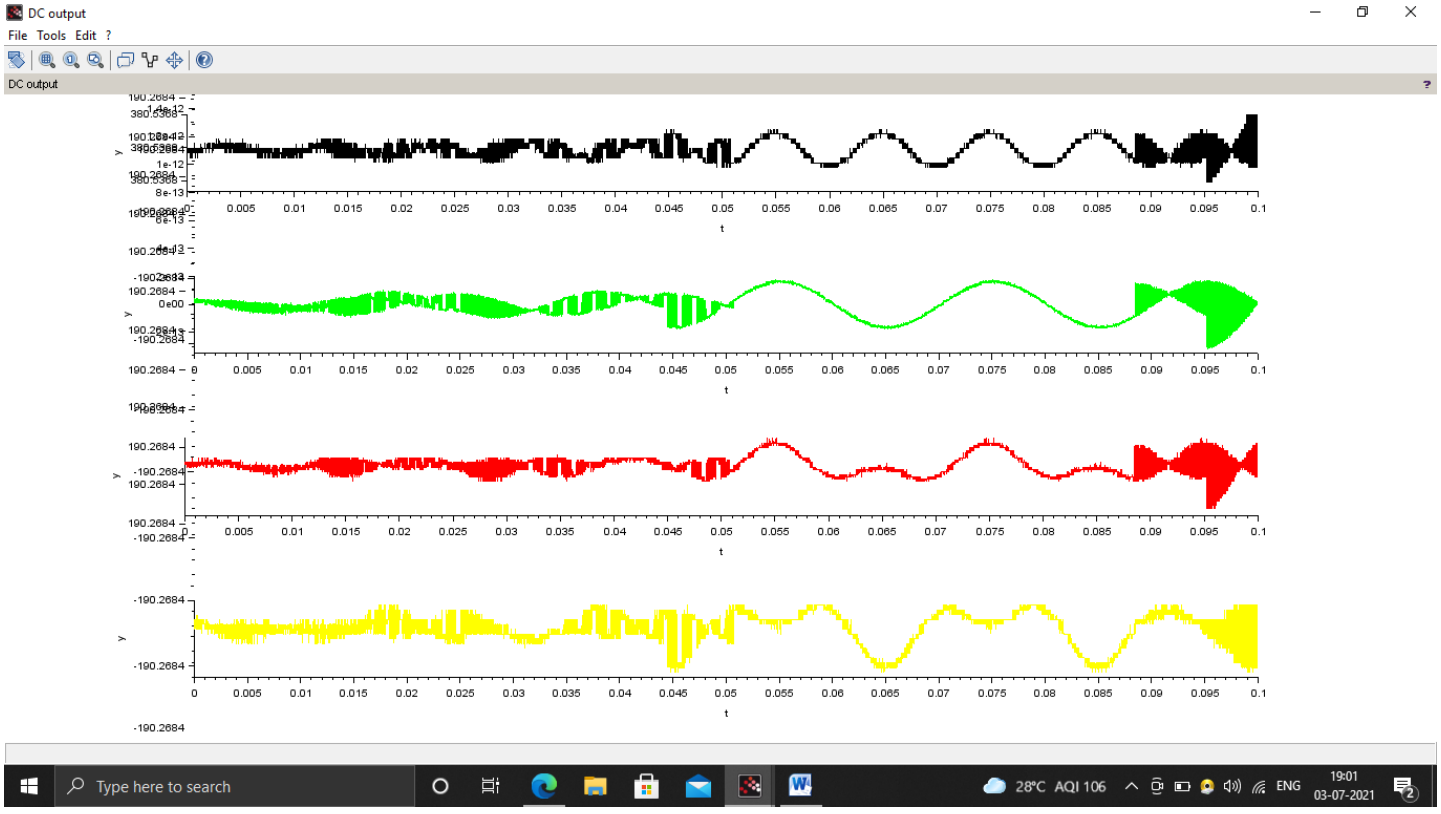
Duty Cycle = 0. 0.03157 (Buck Converter) and 0.969(Boost Converter)

Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

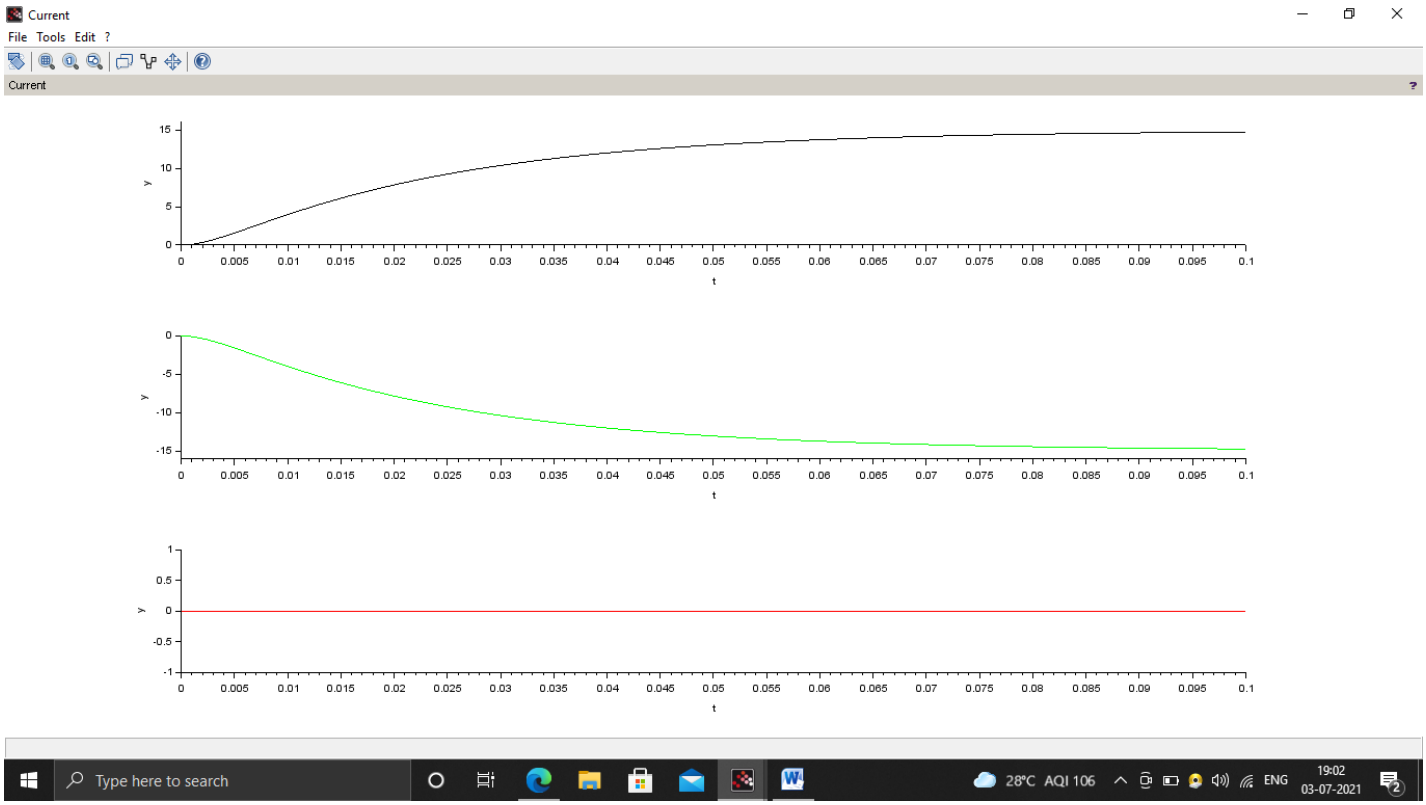


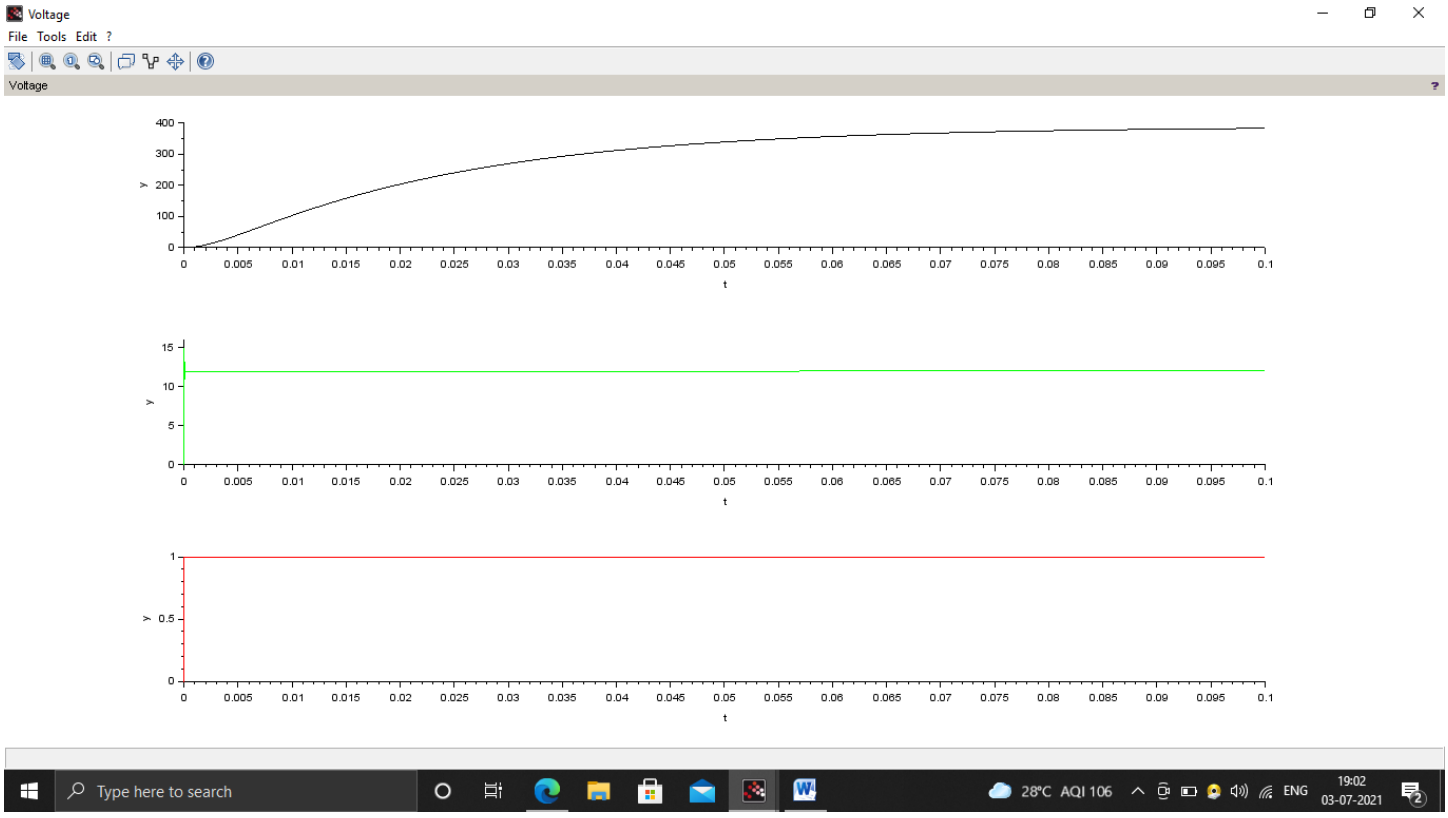


Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675



Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675





Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

Task 2:

A DC motor is scheduled to be actuated for testing purposes and an electric power test-bench is to be setup to test the motor's functionality. The available supply is 230 Volts, 50 Hz, 3-Phase AC. Due to this limitation a Power Converter Circuit must be introduced to make the necessary power conversions to effectively operate the motor. Your task is to design the required Power Converter circuit which consists of two converters and the output of this circuit is connected to the supply terminals of the DC Motor.

Once the DC Motor has been actuated to the rated Voltage (V_{DC}), apply a closed loop system by adding a PID Controller to tune the system for a perfect velocity response from the motor.

Circuit and Actuator Parameters:

1. DC Motor: V_{DC}= 60 Volts, Inertia= 0.5 N.m, Friction Coefficient= 0.01 N.m.s, Constant (K) = 1.25 N.m/A, R=0.4 ohms, L= 0.05 H.
2. Buck Converter: R= 5 Ohms, L= 12.12×10^{-6}, C= 19.5×10^{-6}, Switching Frequency = 400×10^{3} Hz.

Questions to be answered:

1. Identify the circuits to be applied in the Power Converter.

Ans: Buck converter, 3-phase AC to DC converter.

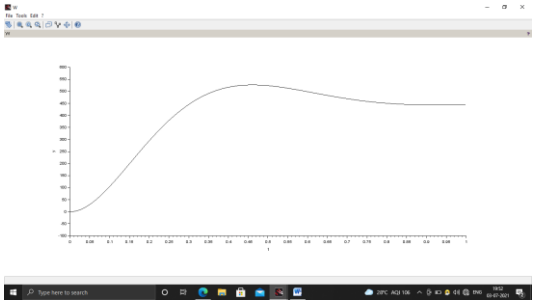
2. What are the changes observed to the output with a change in the switching frequency?

Ans: If the switching frequency is very low, we get a constant oscillation of buck converter voltage.

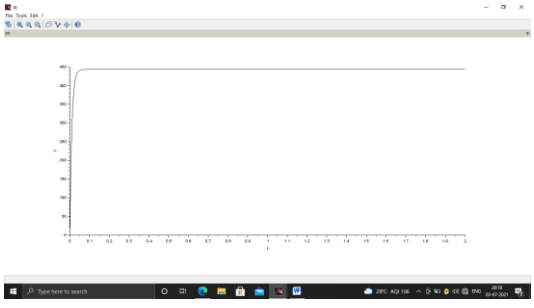
If the switching frequency is very high, we get an increment in the voltage but decreased oscillation.

3. What are the differences observed in the velocity graph of the motor with and without a PID Controller?

Ans:



Without PID Controller



With PID Controller

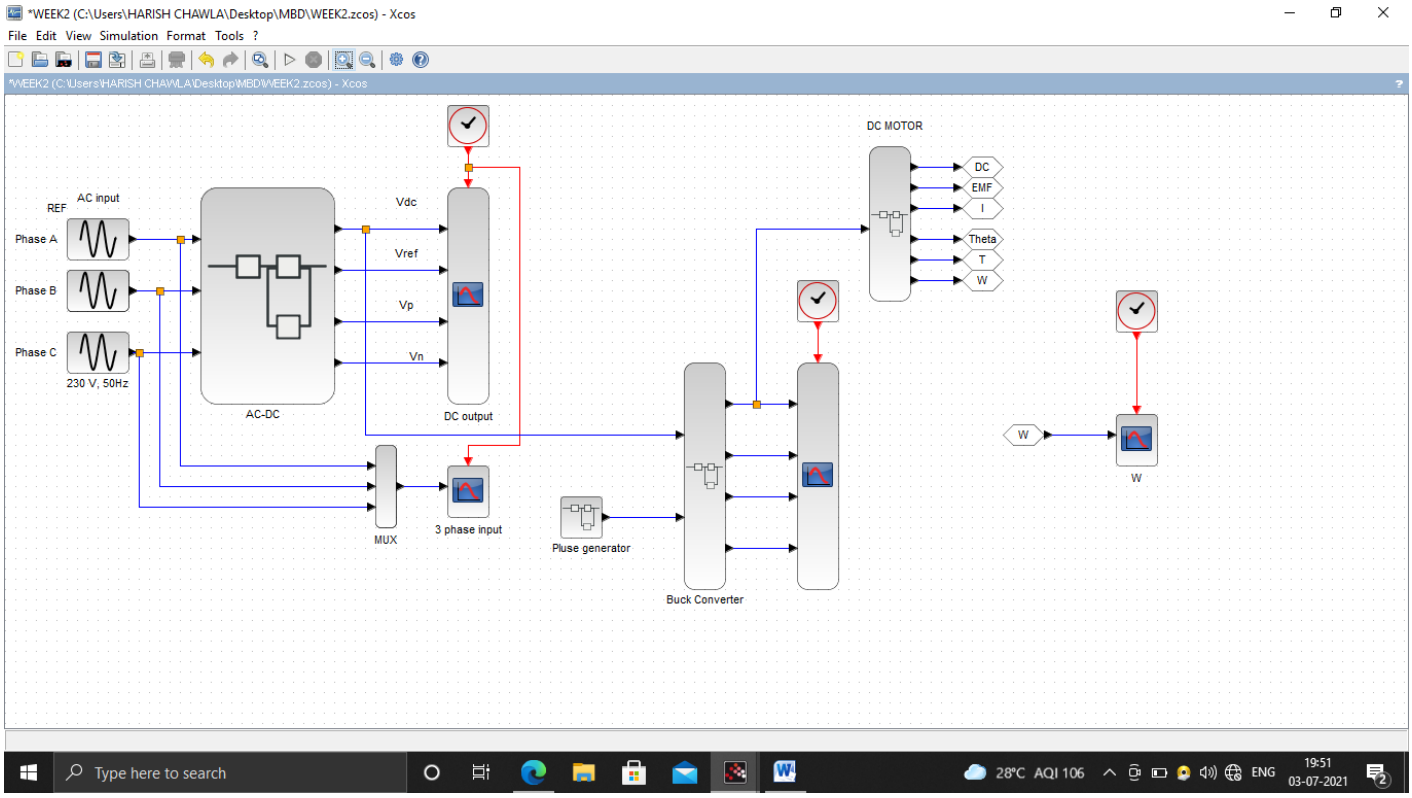
Parameters to be observed via the Scope:

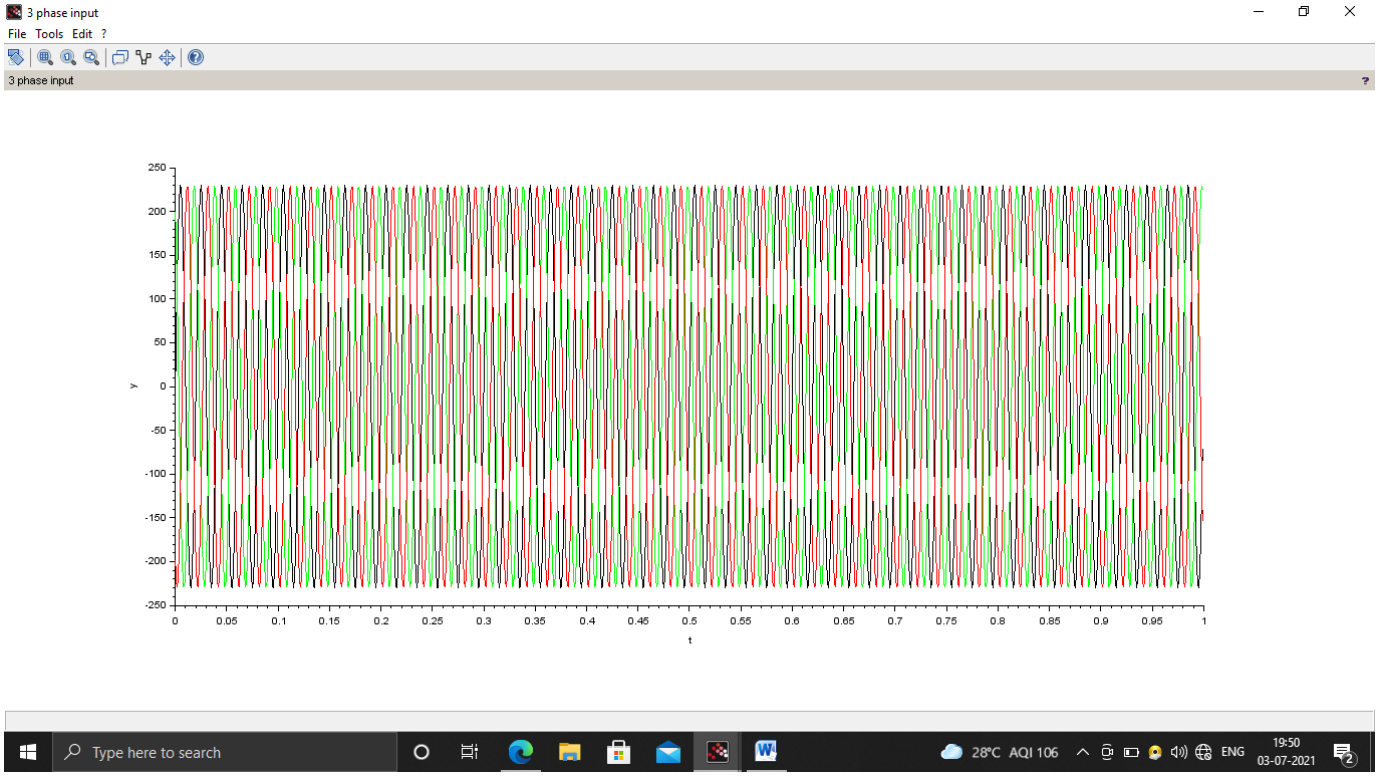
1. Output Voltage of Power Converter
2. Load Current Buck Converter
3. Inductor Current of Buck Converter
4. PWM Signal
5. DC Motor Velocity

Duty cycle=0.15678

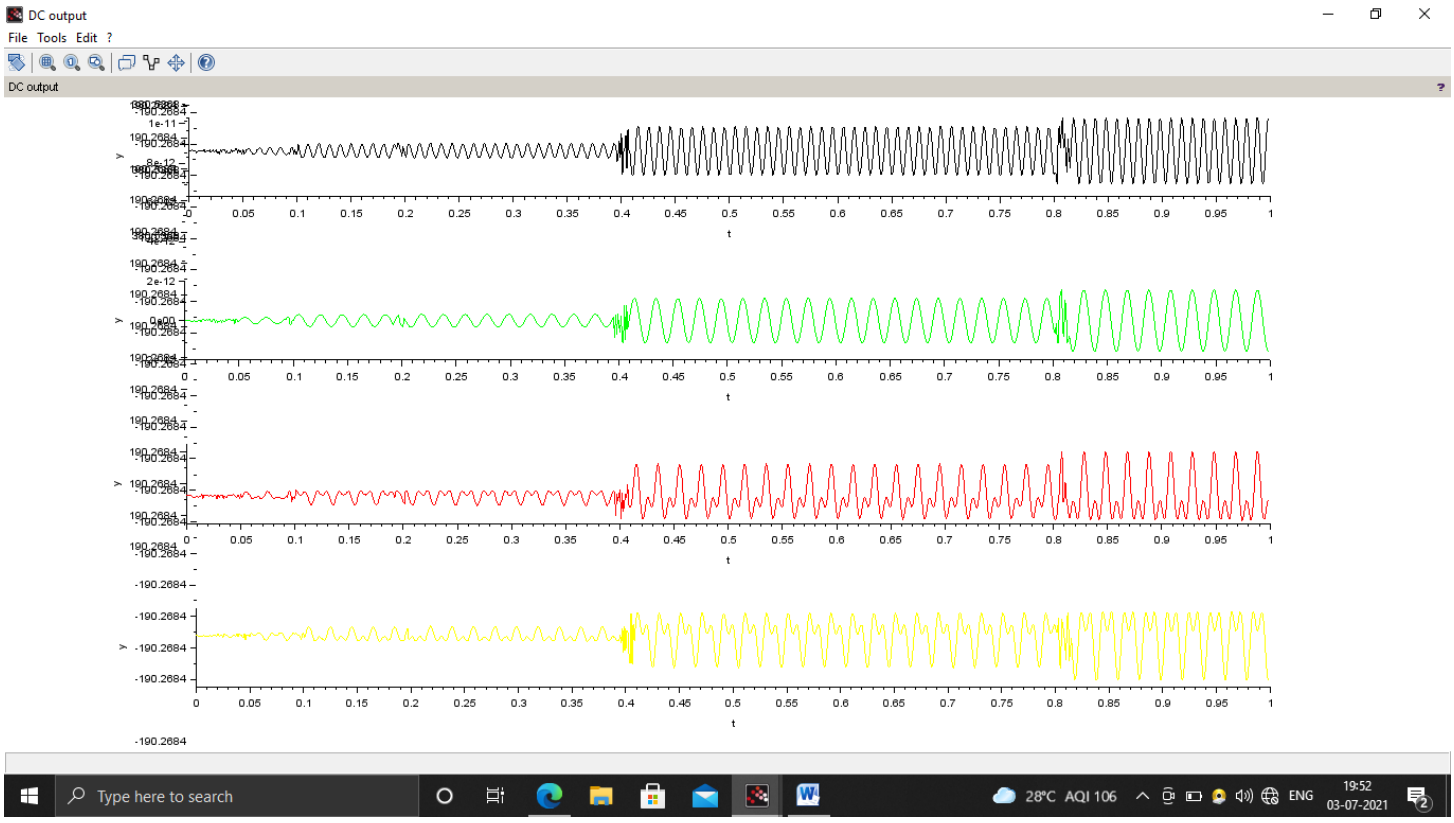
Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

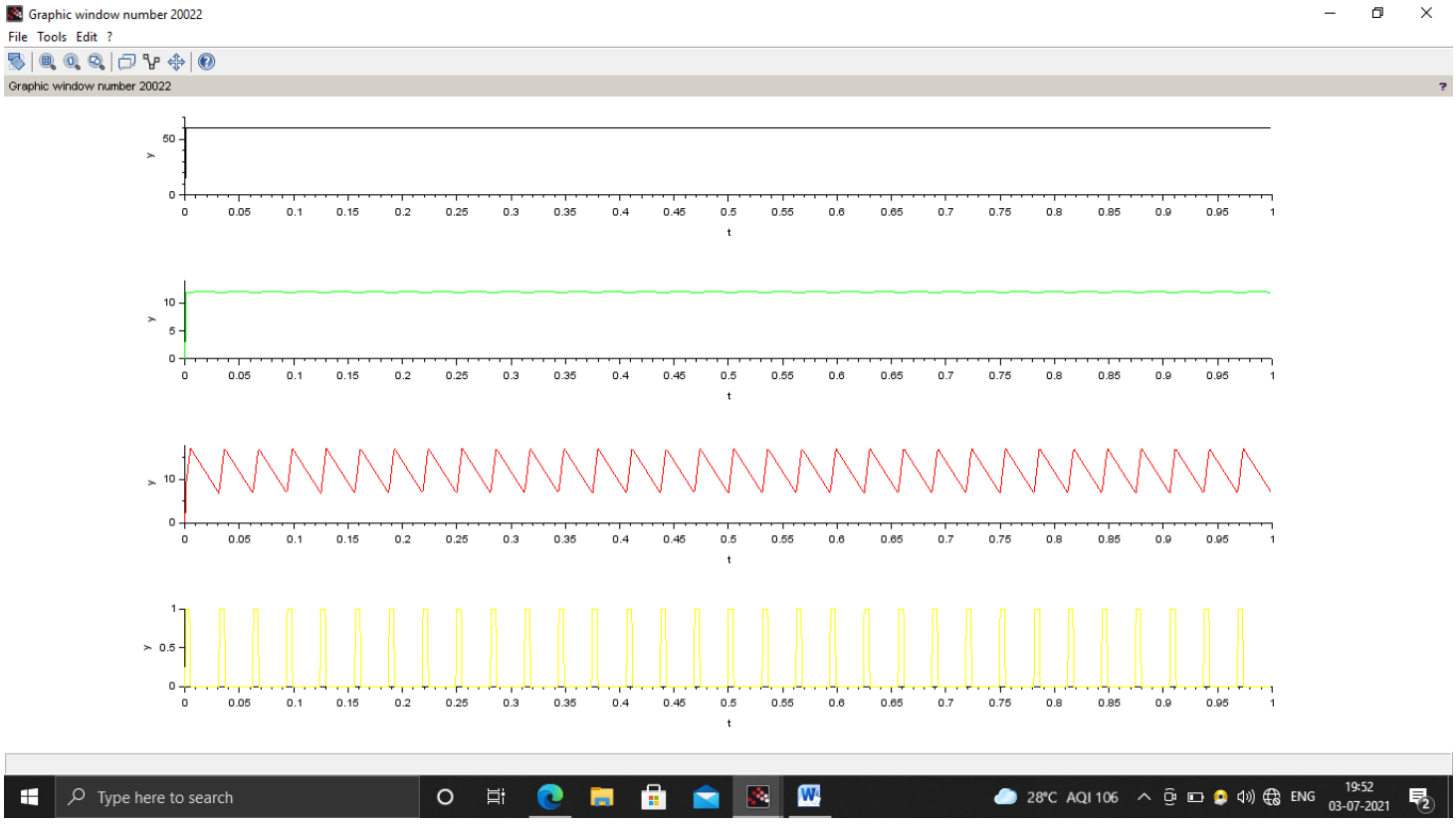
TASK 2 PART 1: Without PID Controller.



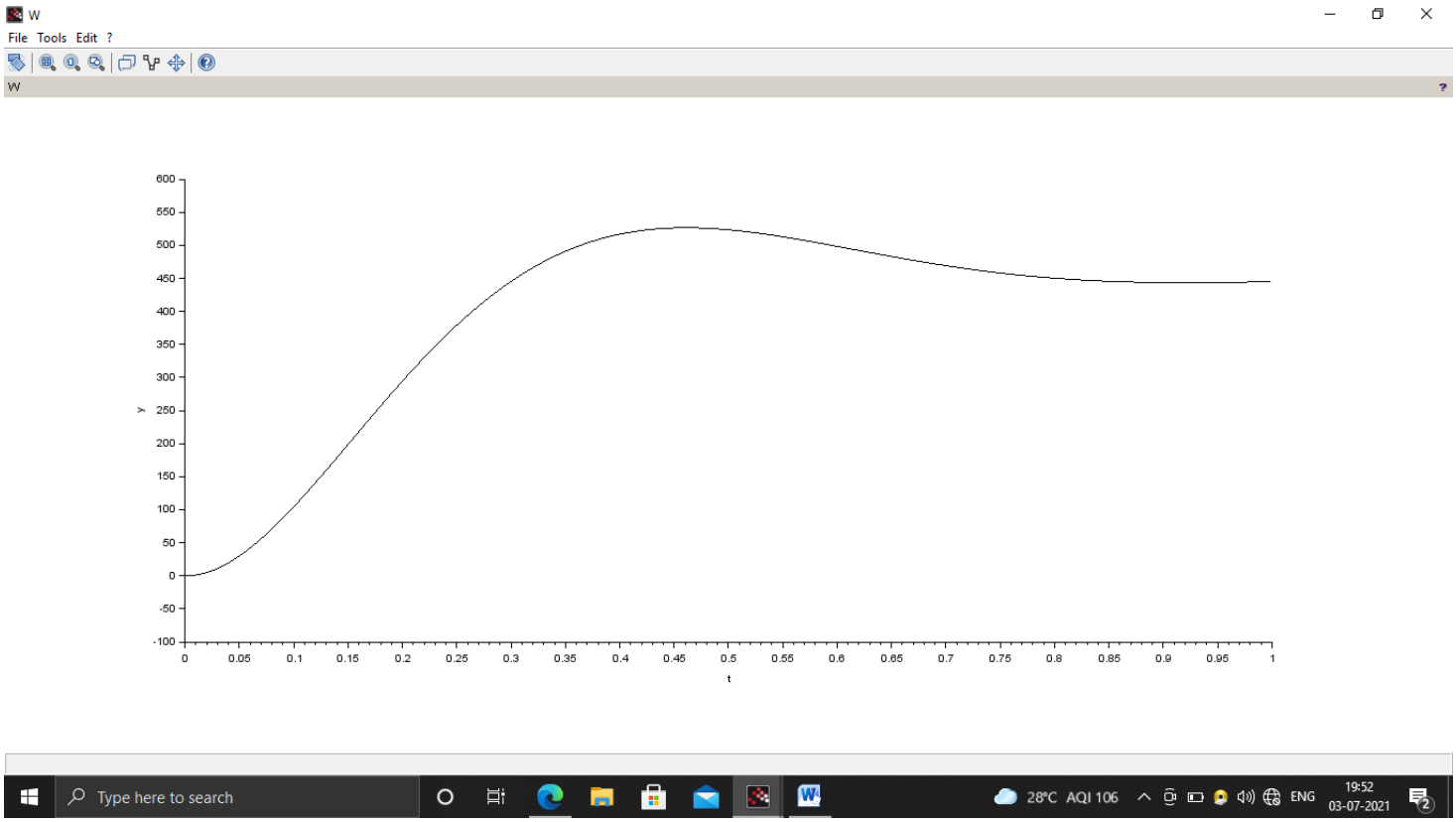


Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

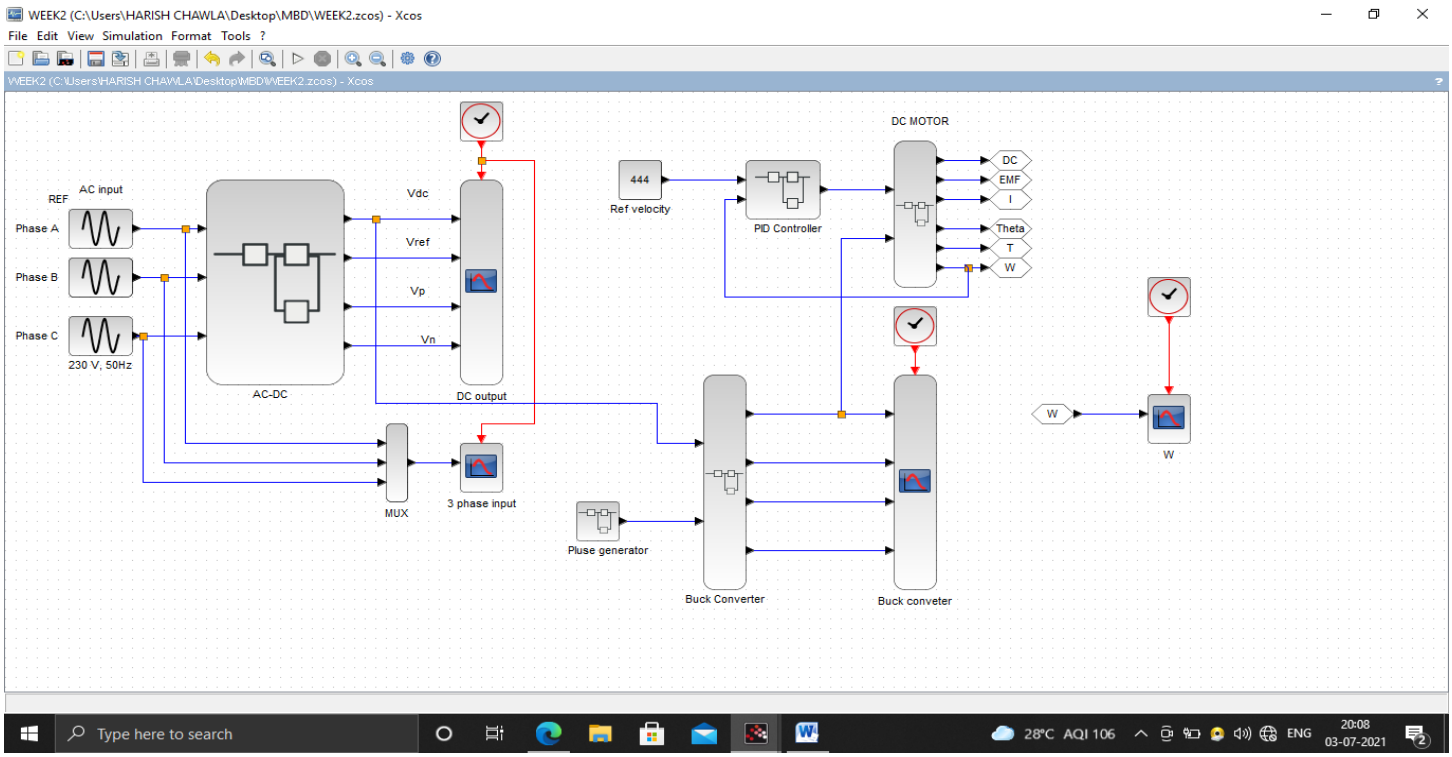




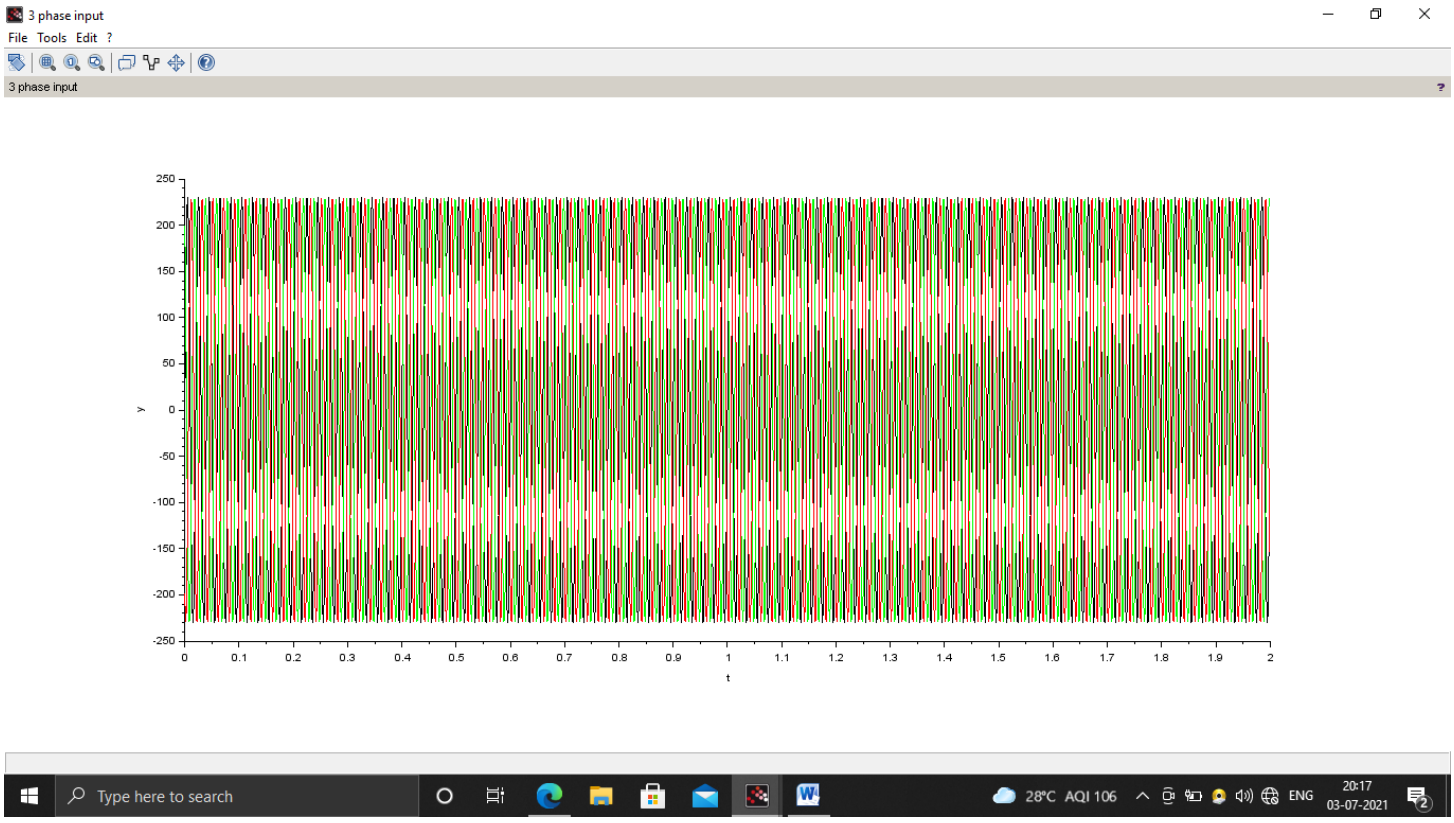
Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675

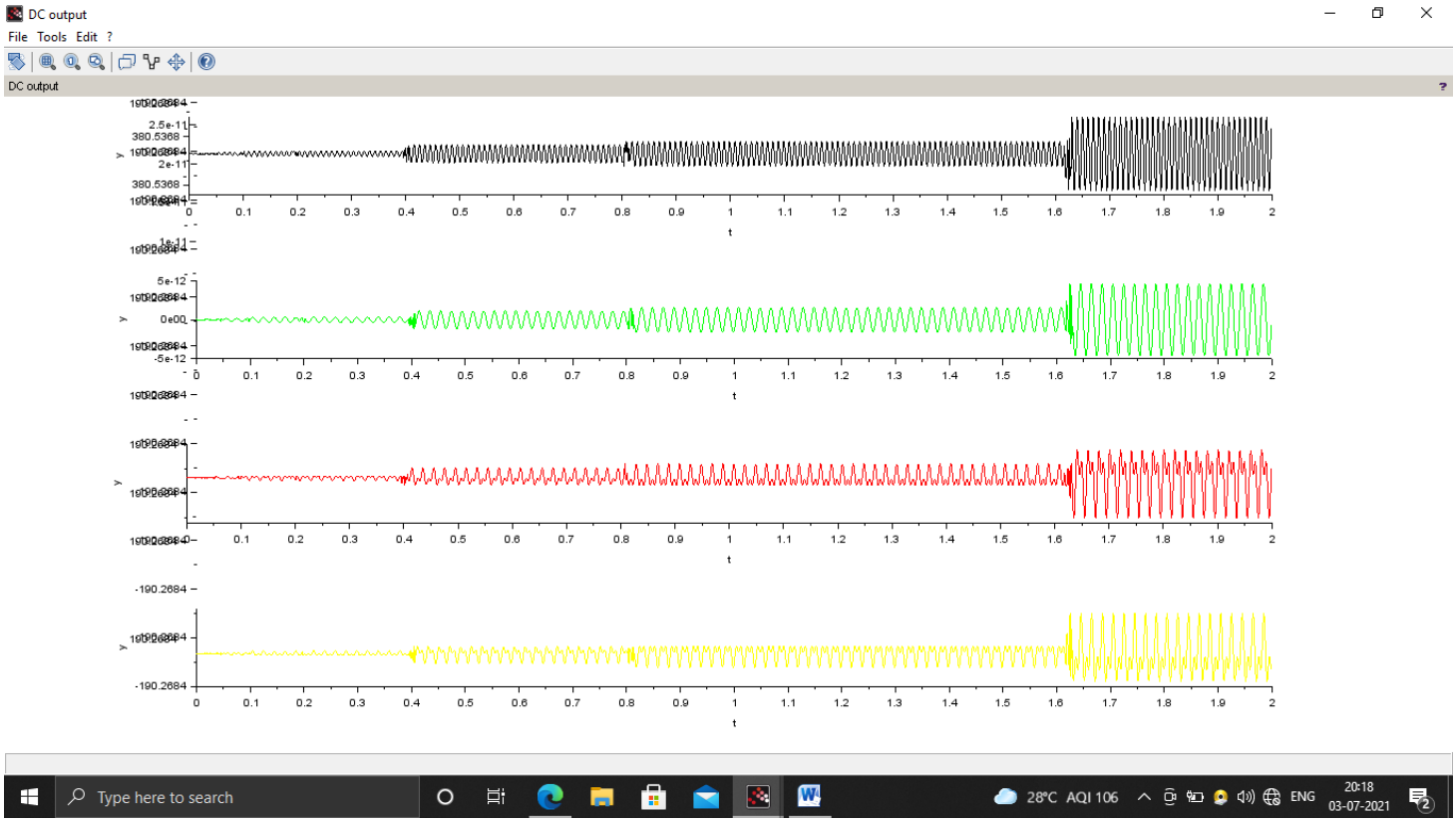


TASK 2 PART 2: With PID Controller.



Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675





Decibels Lab Private Limited
#2362, 24th main road, 1st sector, HSR layout
Bangalore, Karnataka – 560102
+91 7411019255 | contact@decibelslab.com
CIN: U80904KA2019PTC126675