

Mathematical Modelling of Electrical and Electronic Systems

Week 3: Assignment

Task 1:

A 230 Volts, 50Hz, 3-Phase AC Supply has been connected to a Power Circuit Grid which is tasked to convert the alternating current to a direct current supply. The voltage at the output terminals of the grid is 12V DC. Design a model to simulate the working of this Power Circuit Grid to obtain the target voltage output. One of the circuits in the grid has the component ratings: Resistance = 5 Ohms, Inductance = 12.12×10^{-6} , Capacitance = 19.5×10^{-6} , Switching Frequency = 400×10^3 .

Questions answered:

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

Ans: AC to DC converter and a Buck converter.

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

Ans: Duty Cycle through pulse generator

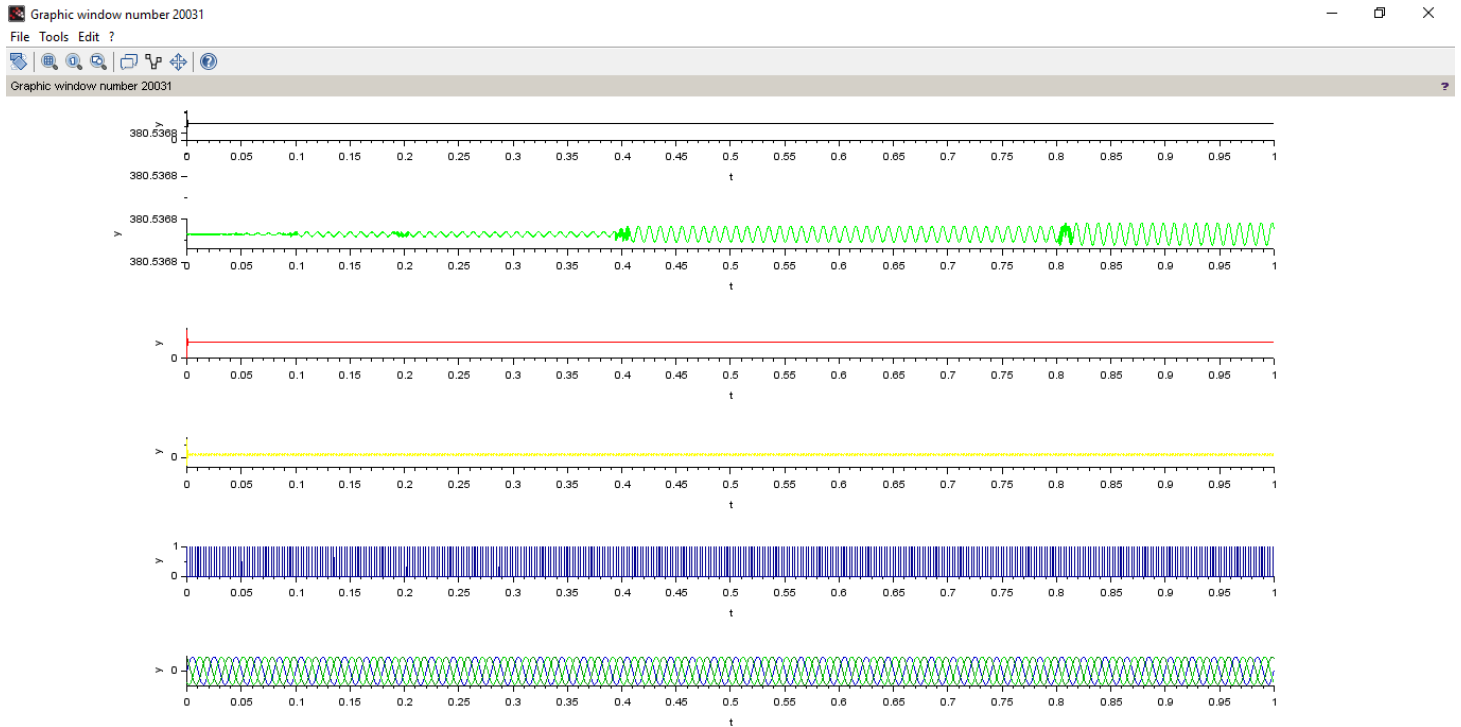
3. Any alternative parameter(s) that can be modified to obtain an identical output?

Ans: Simulation time.

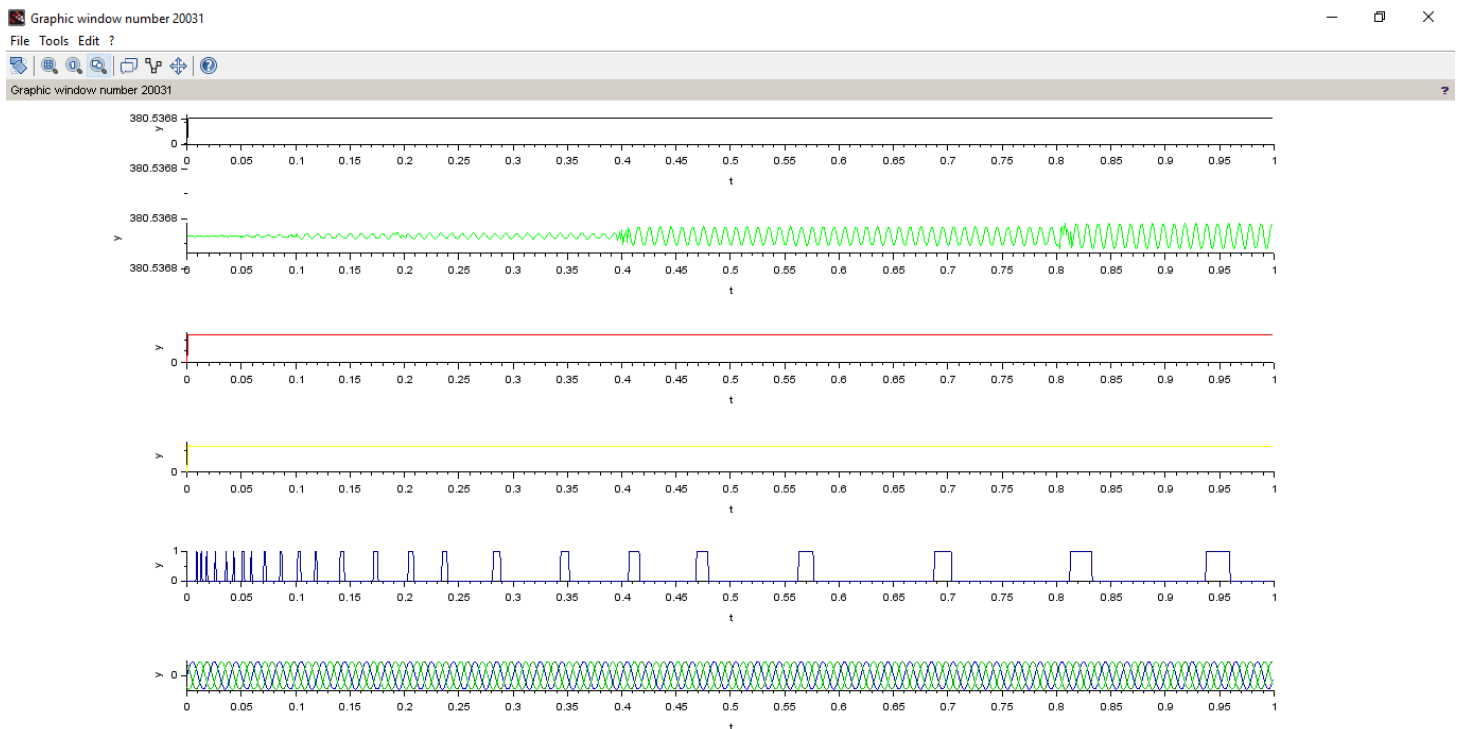
The following parameters are observed via the Scope in the following order:

1. Output Voltage
2. Intermediate Voltage
3. 3-phase Input Supply
4. Load Current
5. Inductor Current
6. PWM Signal

DC=0.031($V_o/V_{in} = 12/380 = 0.031$), Simulation time=0.00001



DC=0.318, Simulation time = 0.001



Task 2:

A 25 Volt DC Supply has been provided to a power converter circuit having the following parameters: Resistance = 5 Ohms, Inductance = 12.12×10^{-6} , Capacitance = 19.5×10^{-6} , Switching Frequency = 400×10^3 . Design a model to simulate the power circuit providing the following outputs: (i) $V_{out} = 20$ Volts, (ii) $V_{out} = 3$ Volts.

Questions answered:

1. Identify the parameter to be modulated to obtain the respective output voltages.

Ans: Duty cycle.

2. Can the Resistor, Capacitor and Inductor values be modified to obtain the same result while keeping the initial control parameter constant?

Ans: Yes, we can provided that we have an inflexible buck converter.

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

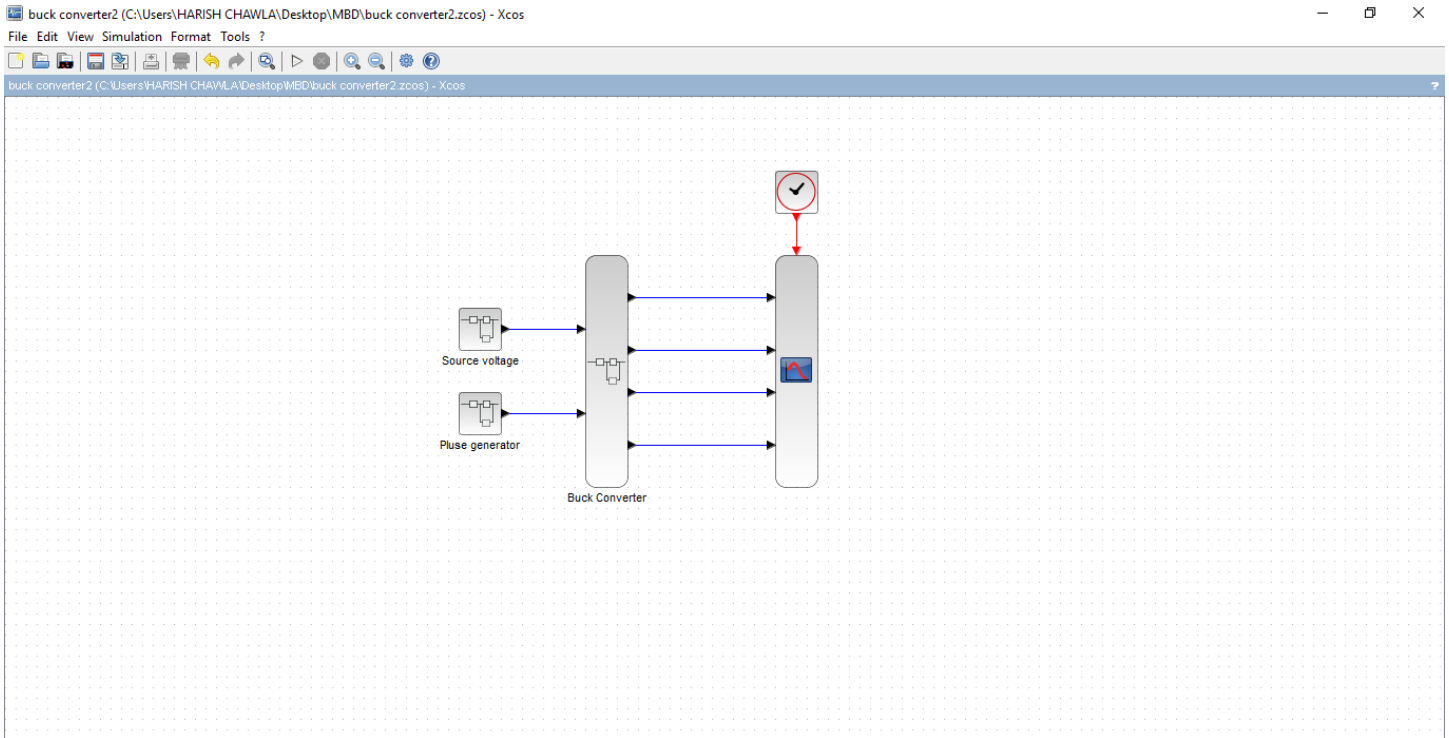
Ans: If the switching frequency is very low, we get a constant oscillation of buck converter voltage.

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

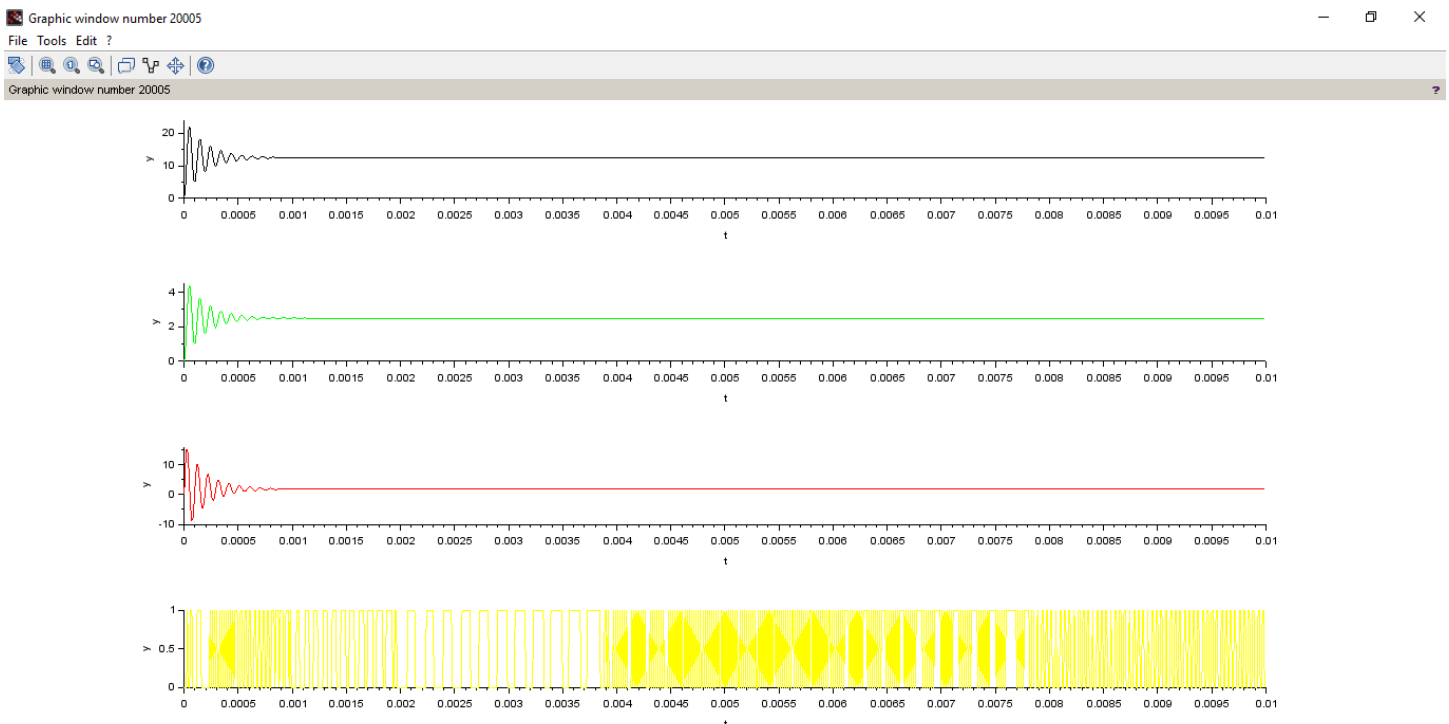
Parameters observed via the Scope in the following order:

1. Output Voltage
2. Load Current
3. Inductor Current
4. PWM Signal

Model:



DC = 0.5, simulation time=0.00001 (random value)



i) DC = 0.8 ($V_o/V_{in} = 20/25 = 0.8$)



ii) DC = 0.12 ($3/25=0.12$)

