SEPIC CONVERTER

Circuit Simulation done by

J.LEON BOSCO RAJ, Assistant professor,

Department of EEE,

St.Xavier's Catholic College of Engineering, Nagercoil.

Theory

The power circuit diagram of the SEPIC is shown in Figure 1. It includes DC input supply voltage v_{in}, capacitors C_1 and C_2, inductors L_1 and L_2,switch S (MOSFET), diode D_1 and the load resistance R. It is assumed that the components are ideal and also SEPIC operates in Continuous Conduction Mode (CCM).

Figure 2 and Figure 3 show the modes of operation of the SEPIC. In Figure 2, when the switch S is closed, the diode is reverse biased, the inductor L_1 is energised by the source voltage V_{in} , while the L_2 charges the capacitor C_1.The polarity of the inductor current and capacitor is shown in Figure 3. The current i_{L1} increases at the rate given by equation (1)

$$\frac{di_{L_1}}{dt} = \frac{v_{in}}{L_1}, 0 \leq t \leq dT - - - - - - - - (1)$$

$$v_{in} = v_{c_1} - - - - - (2)$$

where v_{c_1} is the voltage across the capacitor C_1, d is the duty cycle and T is the switching period. In Figure 1.3, when the switch is open, diode D_1 is forward biased, the inductor L_1 charges the capacitor C_1 and the inductor L_2 charges C_2 . Under this condition, the equations (3) and (4) are valid.

$$i_{in} = i_{L_1} - - - - - - (3)$$

$$i_{L_2} = i_D = i_o - - - - (4)$$

where i_{Da} is the average current of diode D_1 and i_o is output current. When the SEPIC is operating in CCM, the voltage conversion ratio of the SEPIC can be obtained from the volt second balance of the inductor L_1 in one switching period and is given by equation (1.4).

$$\frac{v_o}{v_{in}} = \frac{d}{1-d} - - - - - - (5)$$

where v_o is the output voltage of the SEPIC converter.

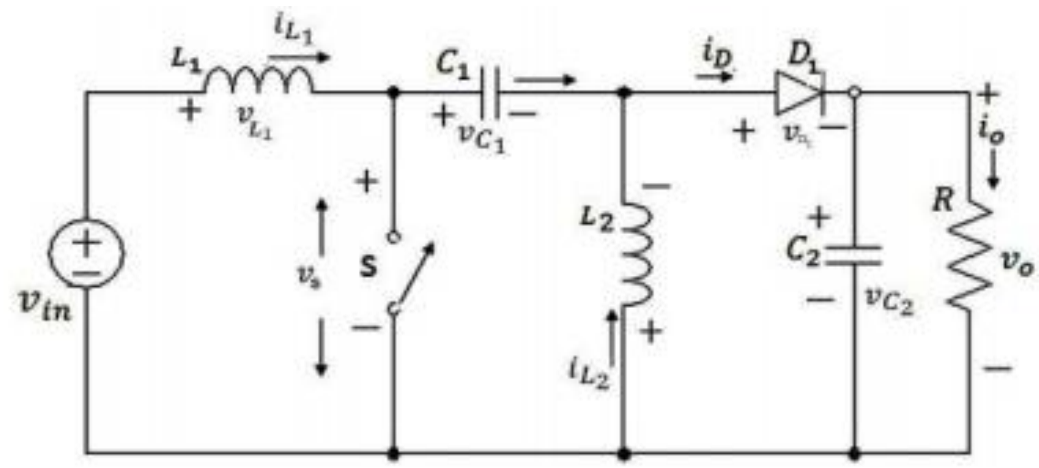

Figure 1 Circuit diagram of SEPIC converter

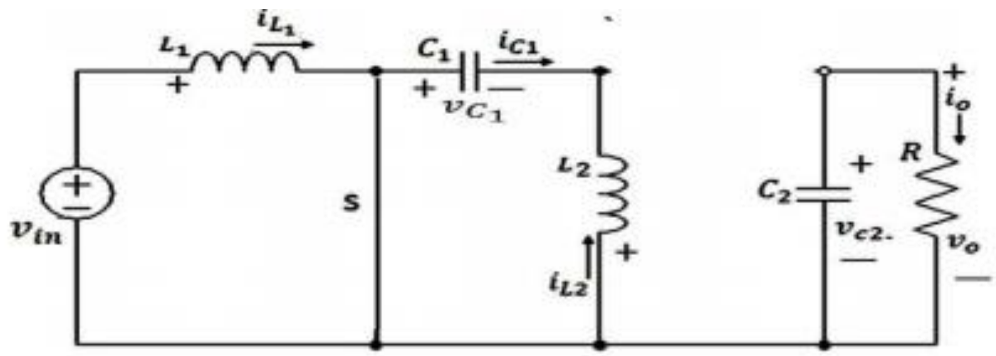

Figure 2 SEPIC converter during switch in ON condition

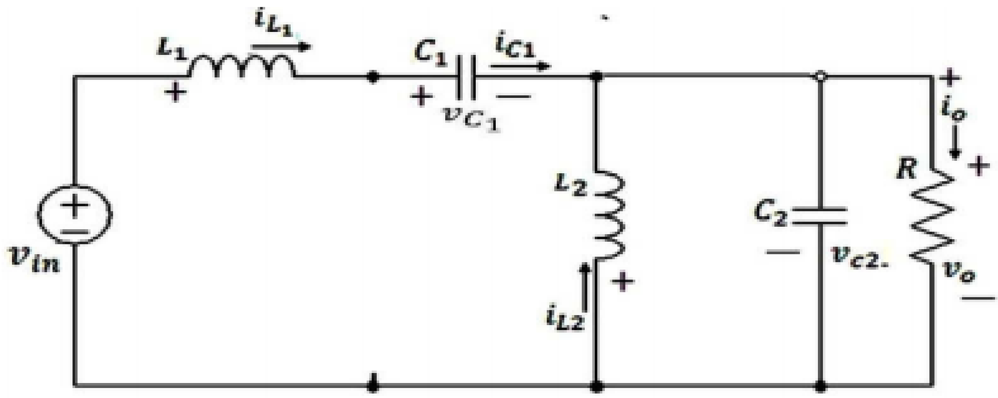

Figure 3 SEPIC converter during switch in OFF condition

$$\boldsymbol{Note}: L_1 = 90\mu H, L_2 = 90\mu H, C_1 = 80\mu F, C_2 = 80\mu F, R = 3.2\Omega$$

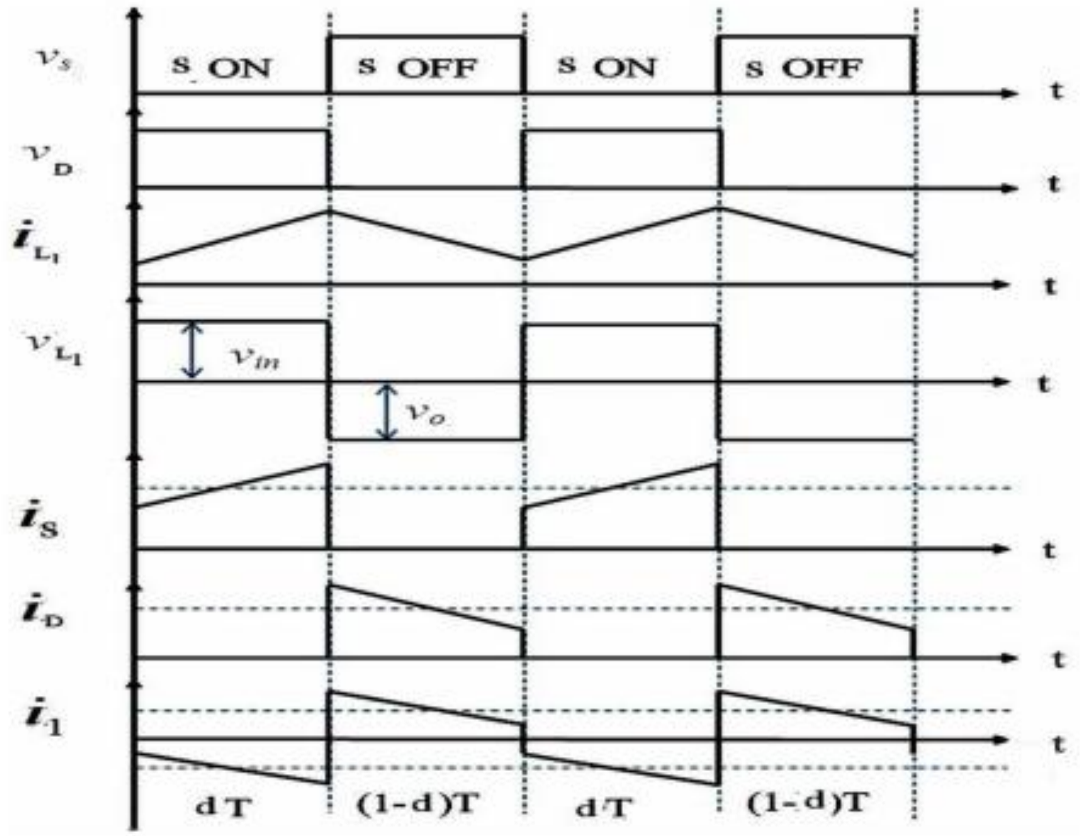

Figure 4 Waveforms of different currents and voltages in SEPIC

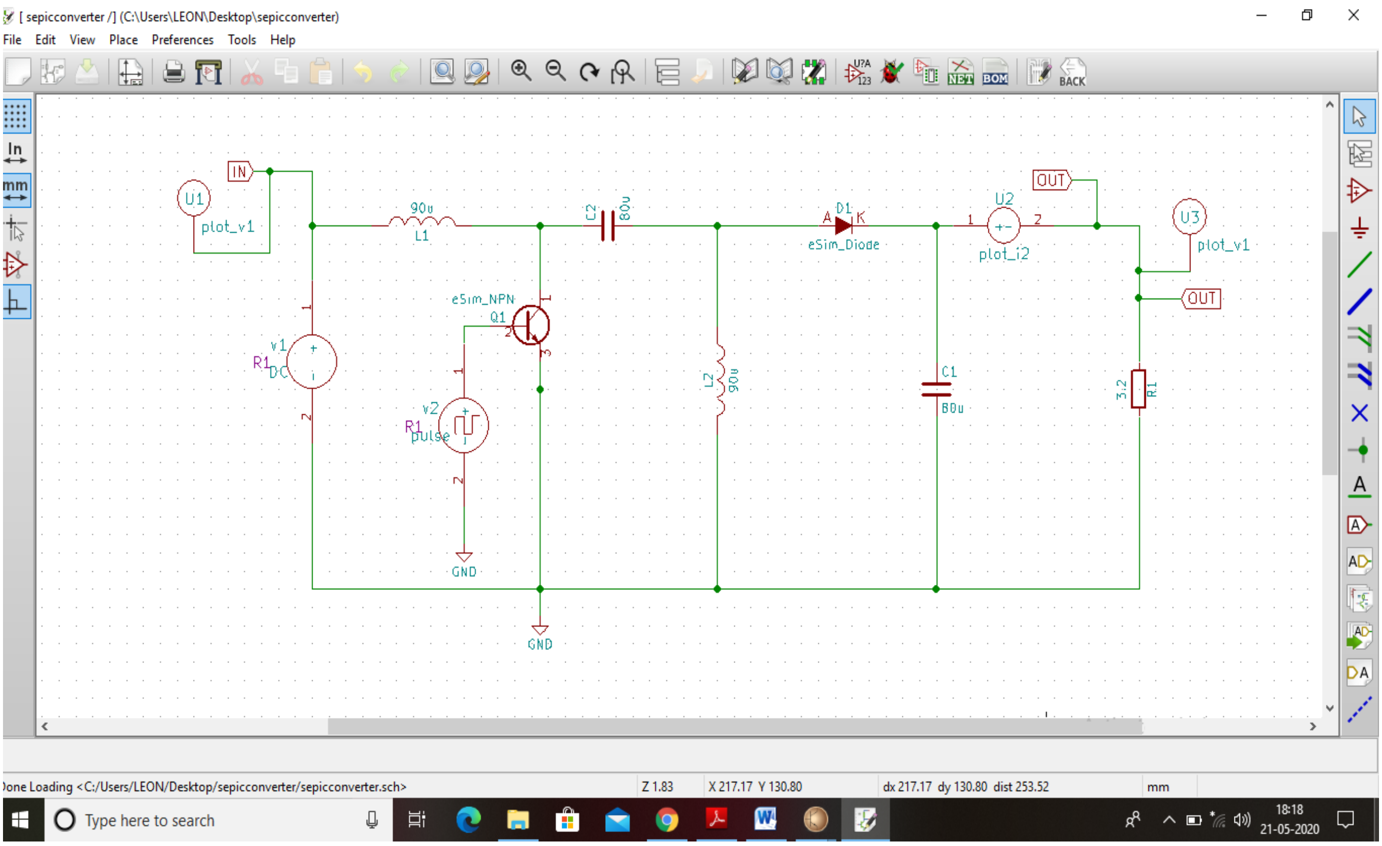

Figure 5: Schematic view of SEPIC converter in eSim

Simulation results

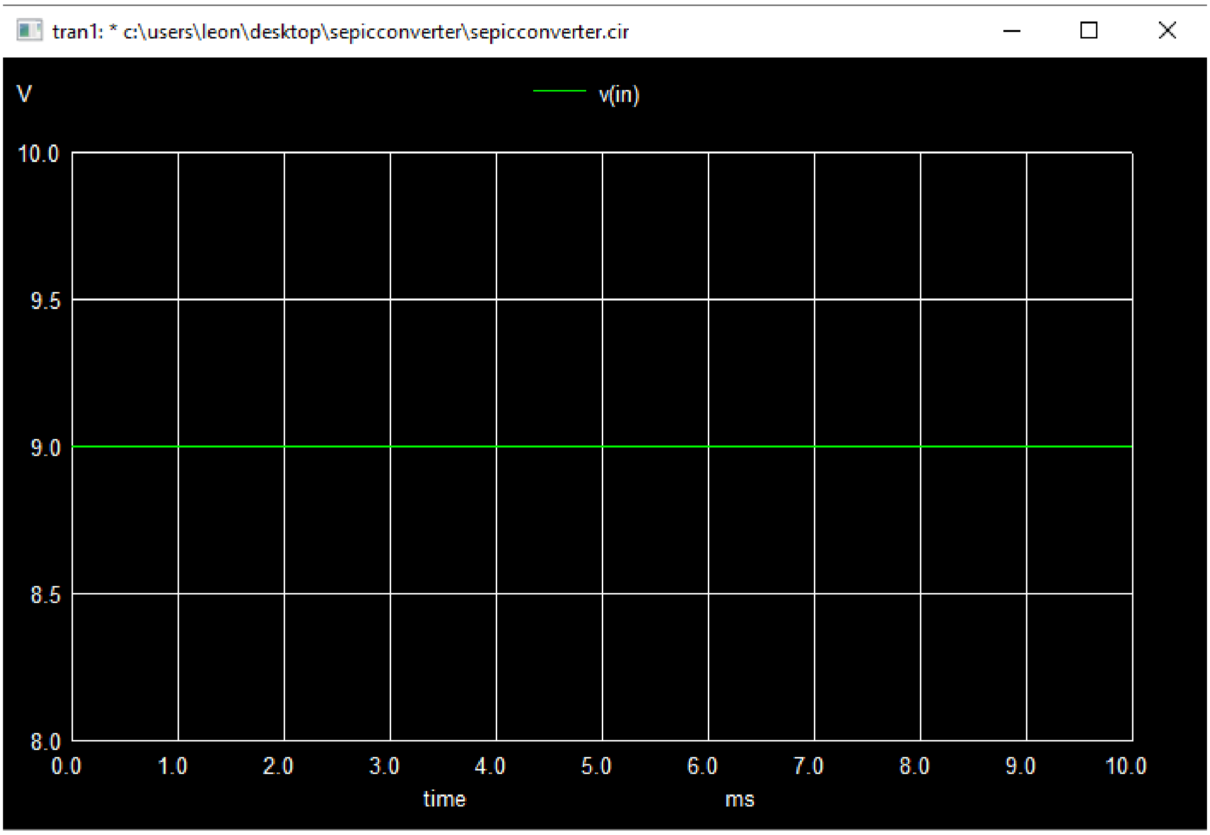

Figure 6: Input voltage wave form

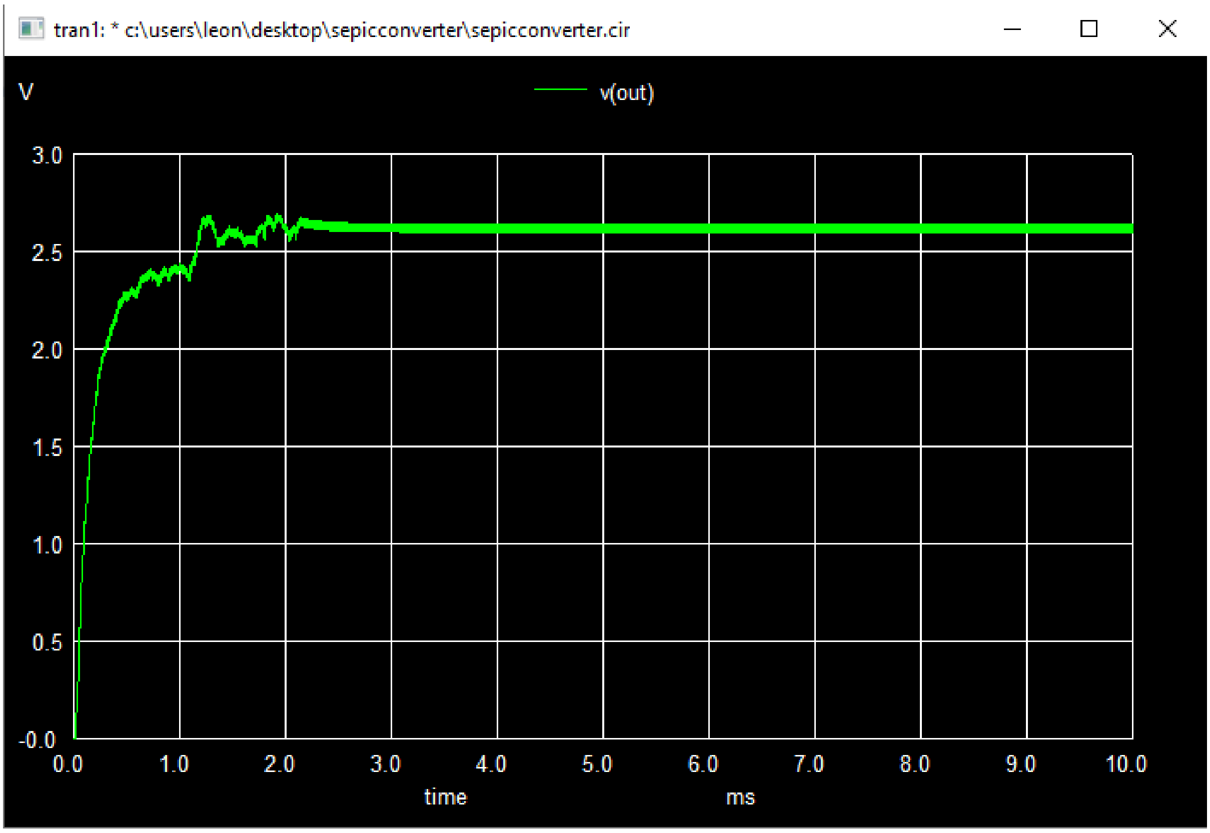

Figure 7: Output voltage wave form

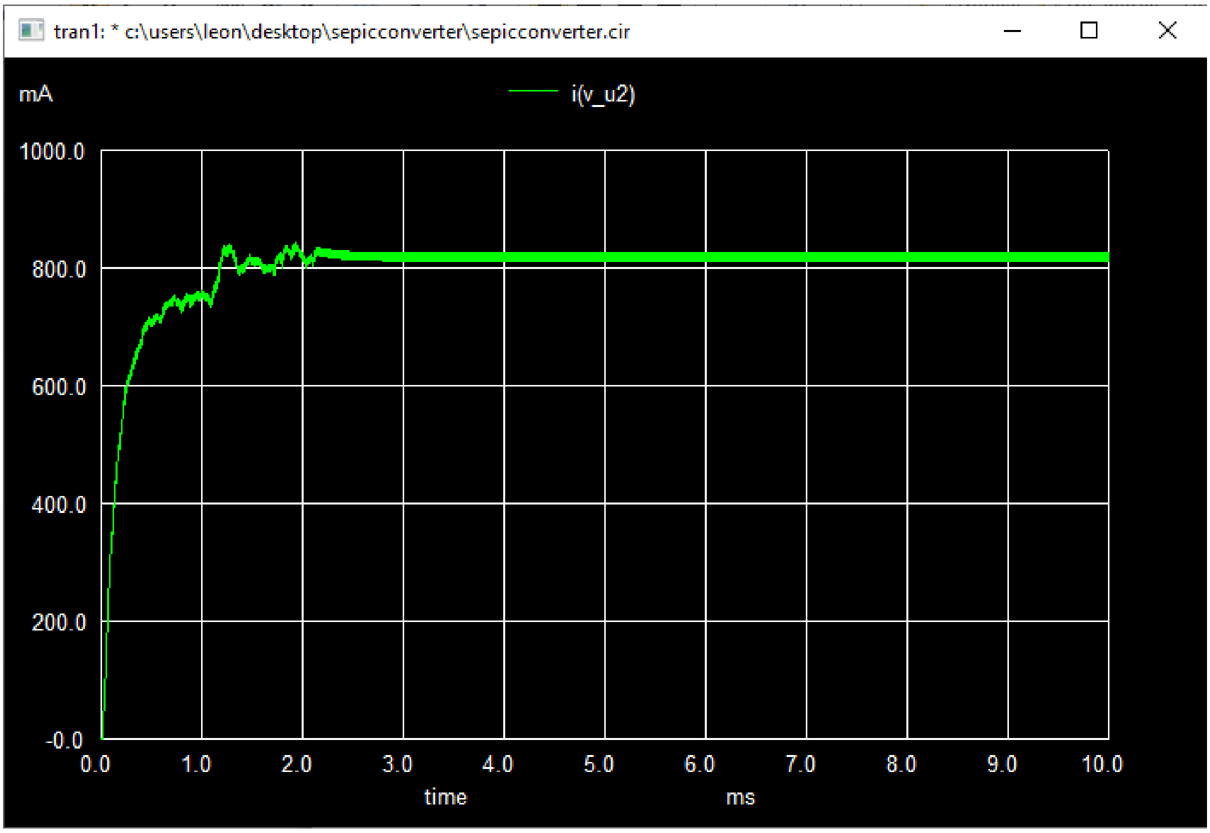

Figure 8: Output Current wave form

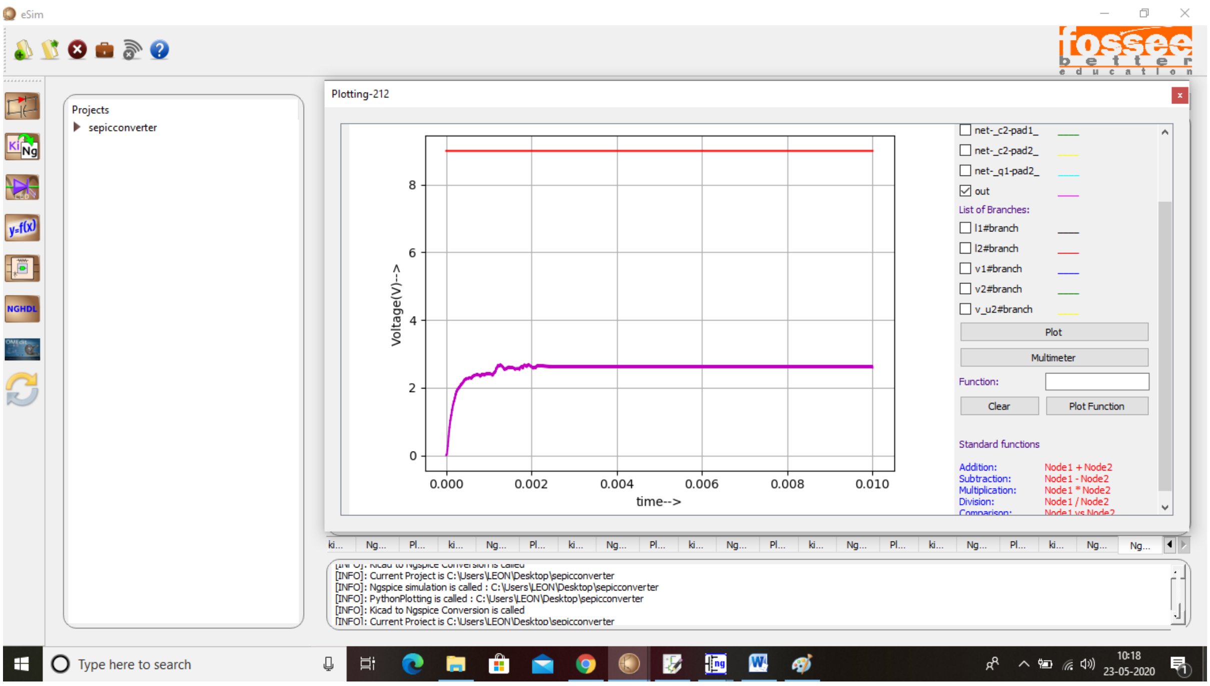

Figure 9: Python plot for input and output voltage waveform

Reference

https://nptel.ac.in/courses/108/105/108105066/ (NPTEL, Power electronics (Web), Lec: 24)