Circuit Simulation Project

https://esim.fossee.in/circuit-simulation-project

Title:

Single-Phase Uncontrolled Rectifier with RL Load and freewheeling diode.

Theory/Description:

Rectifier converts AC supply into DC. Rectifiers are also known as AC-DC converter. Diodes are extensively used in rectifier circuit. Single phase half bridge rectifier is shown in Fig. 1. During positive half cycle of supply voltage D is turn on therefore positive voltage reflects across the load. At zero crossing the diode get turn off. During negative half cycle diode is reversed bias and block the supply voltage.

This circuit simulation of single-phase uncontrolled rectifier with RL load is carried out to analyse the effect of RL load on the Turn on time of diode and to understand the role of freewheeling diode. Due to presence of Inductive component in the DC load, the conduction period of Diode D will extend beyond zero crossing. During positive half cycle current flows through RL load and as the load is inductive, the current lags behind the voltage. Hence the load current continues to flow even after the supply voltage Vs has become zero and then negative. Therefore, diode remains ON till the current decays to zero.

Due to negative part of output voltage the average value of voltage reduced. To improve average output voltage freewheeling diode (FD) is connected across the load. During positive half cycle of supply voltage FD is reversed bias and power is supplied to the load. When the supply is reversed FD get forward biased and conduct during negative half cycle. Therefore, main diode immediately stops conducting however the current freewheels through freewheel diode. The average value of output voltage is improved after connecting a freewheel diode.

Circuit Diagram:

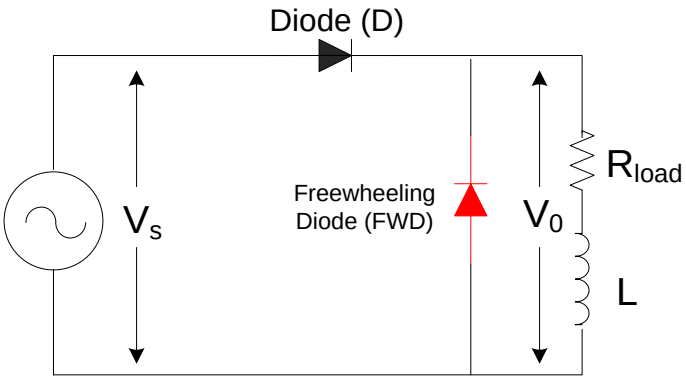

Fig.1 Circuit diagram of single-phase uncontrolled rectifier with RL Load and FWD

Results/ Output (ngspice and Python plots)

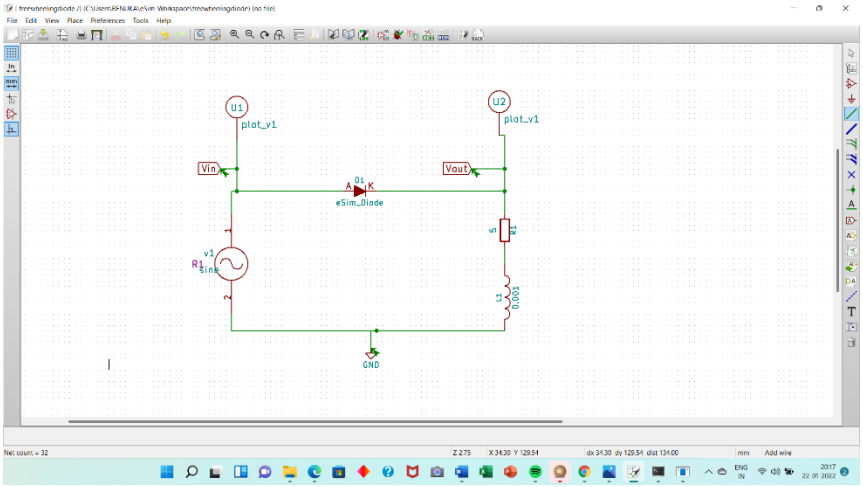

Fig. 3 Single phase uncontrolled rectifier with RL load without freewheeling diode in esim

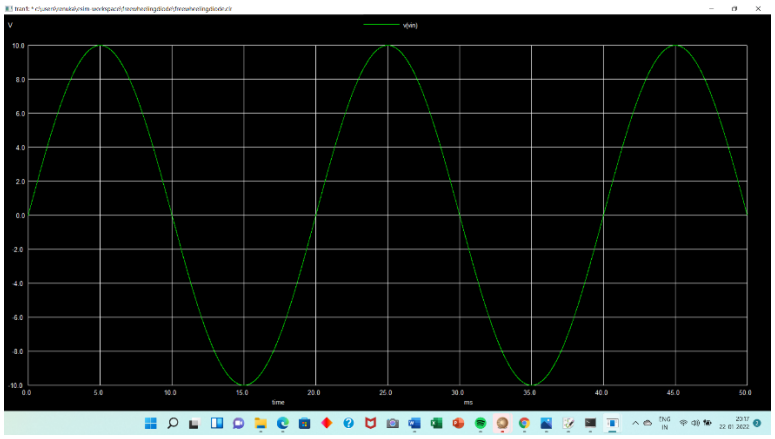

Fig. 4 Ngspice plot of Input Voltage Vs without freewheeling diode

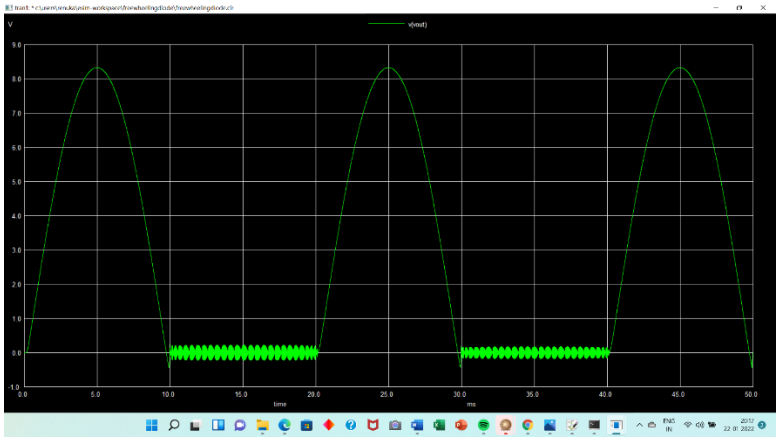

Fig. 5 Ngspice plot of Output Voltage V_0 without freewheeling diode

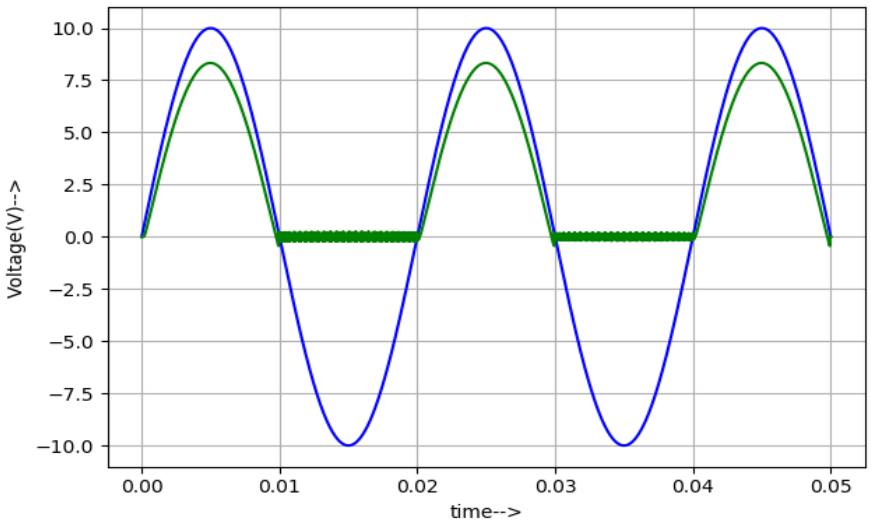

Fig. 6 Python plot of Input/Output Voltage Vs/V_0 without freewheeling diode

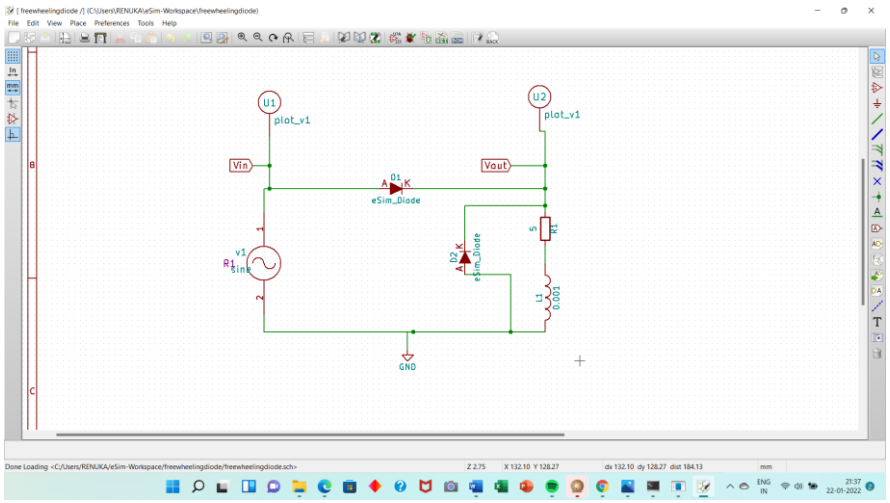

Fig. 7 Single phase uncontrolled rectifier with RL load with freewheeling diode in esim

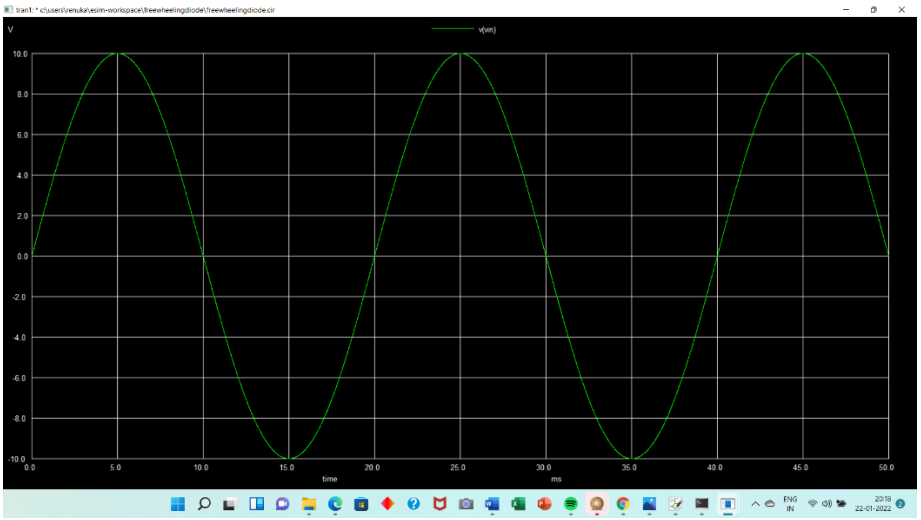

Fig. 8 Ngspice plot of Input Voltage Vs with freewheeling diode

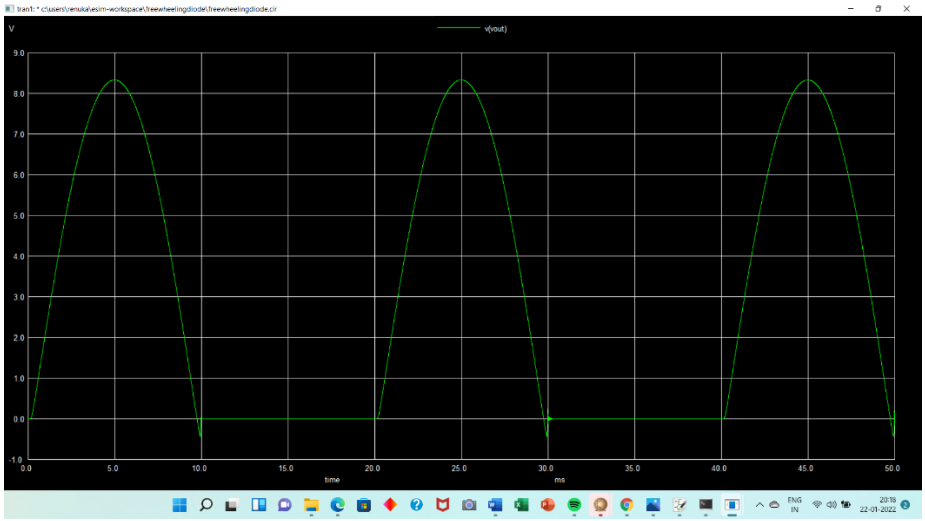

Fig. 9 Ngspice plot of Output Voltage V_0 with freewheeling diode

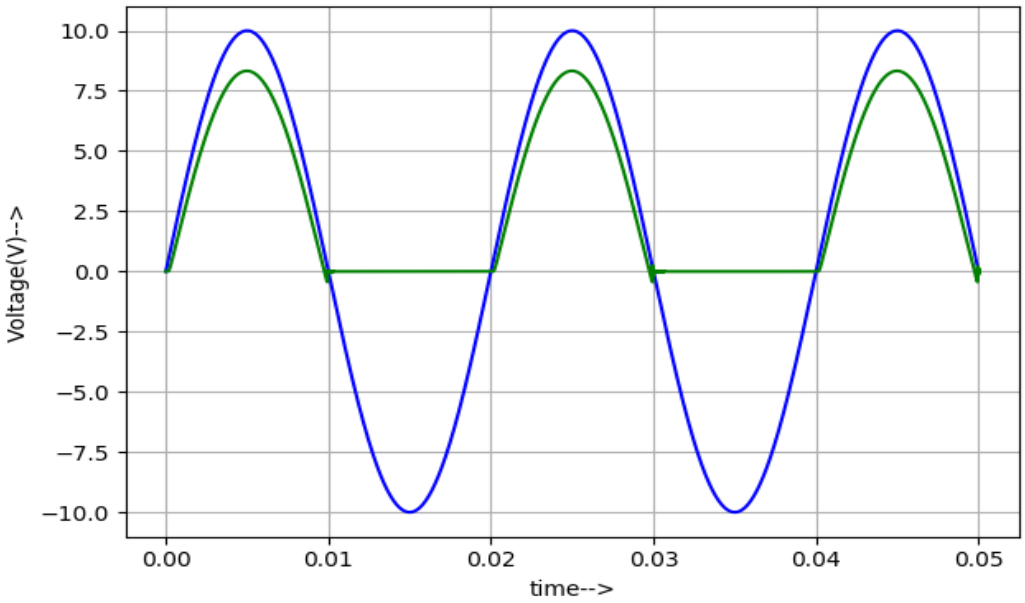

Fig. 10 Python plot of Input/Output Voltage Vs/V_0 with freewheeling diode

Conclusion: Freewheeling diode prevents the load voltage from becoming negative, hence average value of load voltage is improved.

Source/Reference(s): Muhammad Rashid, *Power Electronics Circuits, devices and applications*, 3rd ed, Pearson, 2017, pp.73-74.