Circuit Simulation Project

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

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Title of the circuit: Single phase half wave rectifier with a capacitive filter

Theory:

A half-wave rectifier converts AC to DC by permitting current flow solely during the positive half-cycle of the AC signal, yielding a pulsating DC output. To mitigate this pulsation, a capacitive filter is introduced. During the positive half-cycle, the capacitor charges to the peak voltage of the input. In the subsequent negative half-cycle, the capacitor discharges gradually through the load, ensuring a continuous voltage output and reducing ripple voltage for a stable DC output. The effectiveness of the filter relies on factors like capacitor size and load resistance, influencing the smoothness of the output voltage.

In summary, a single-phase half-wave rectifier with a capacitive filter function by rectifying AC input voltage into DC output voltage, with the capacitor smoothing out pulsations for a more consistent DC output across the load.

1. **AC Input Voltage**: The AC input voltage is applied to the input of the rectifier circuit.

2. **Half-Wave Rectification:** The half-wave rectifier, typically made using a diode, conducts current only when the input voltage is positive, allowing only the positive half of the AC input waveform to pass through.

3. **Capacitive Filtering:** The capacitor is connected across the load resistor. While positive half cycle of the AC input voltage, the capacitor charges to the peak value of the input voltage.

4. **DC Output Voltage:** During the negative half-cycle of the input voltage, the diode is reverse biased, and the capacitor discharges through the load resistor, providing a relatively constant DC output voltage across the load.

5. **Output Ripple Reduction:** The capacitor smooths out the ripples in the output voltage, providing a more stable DC output

1. Schematic Diagram:

The circuit schematic of the Half wave rectifier with a capacitive filter in eSim is as shown below:

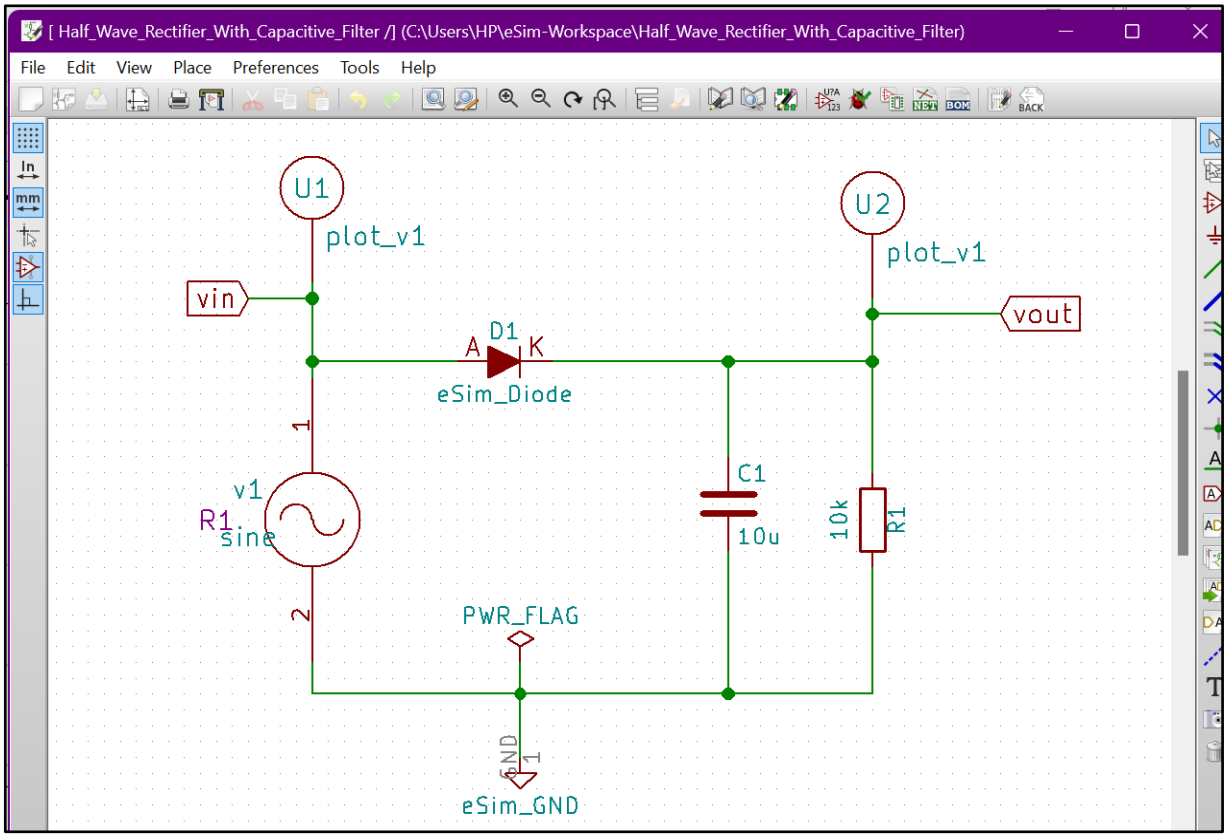

Figure 1: Circuit Schematic - Half wave rectifier with a capacitive filter

2. Input Parameters:

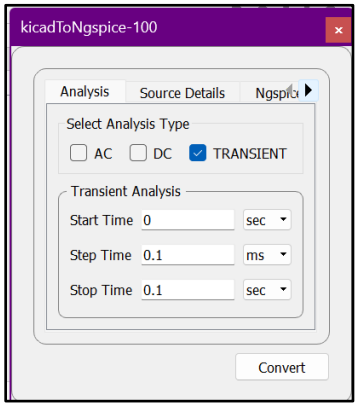

Figure 2: Analysis Parameters

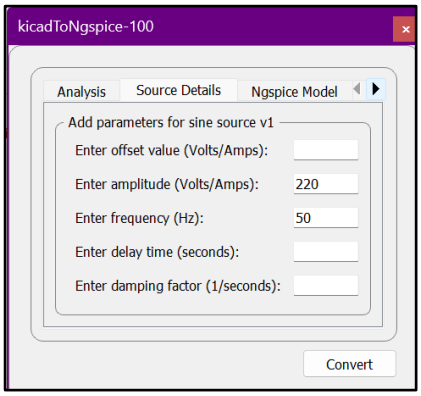

Figure 3: Source Details

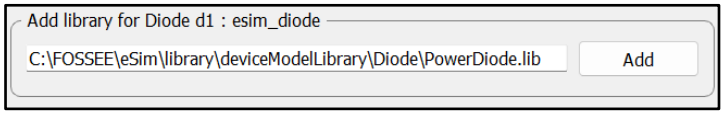

Figure 4: Device Modeling

3. Simulation Results:

1. Ngspice Plots

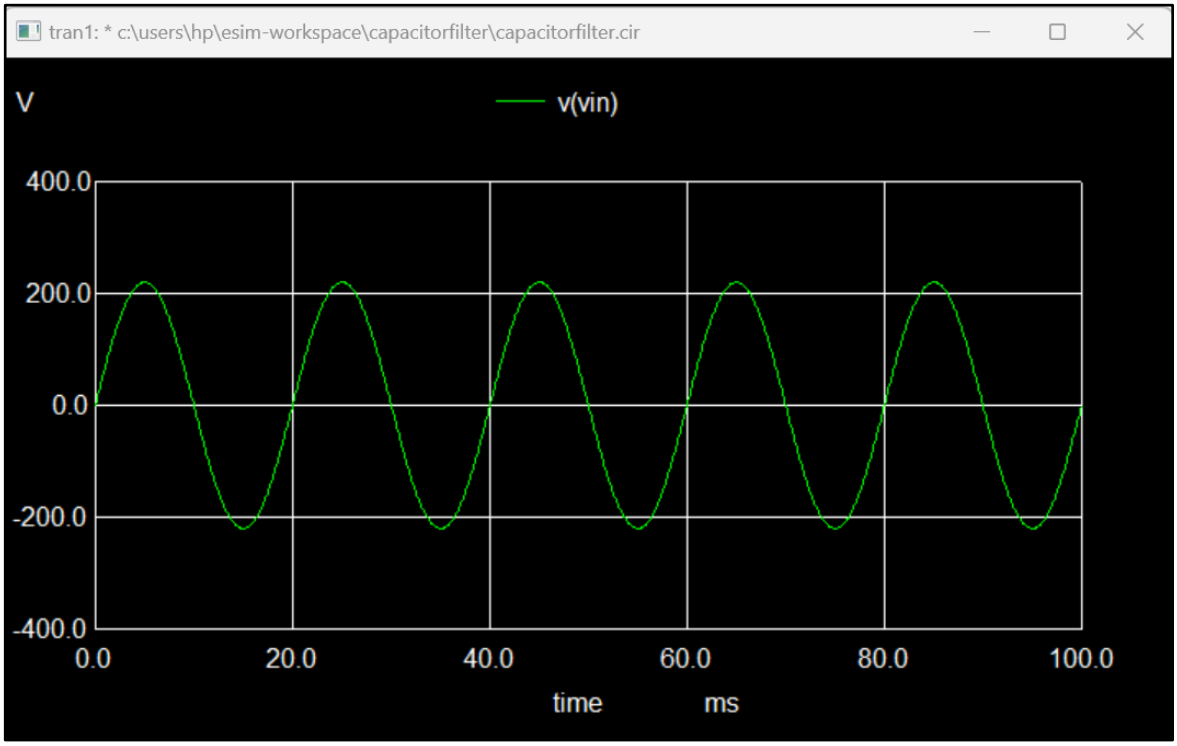

Figure 5: Ngspice Input Plot

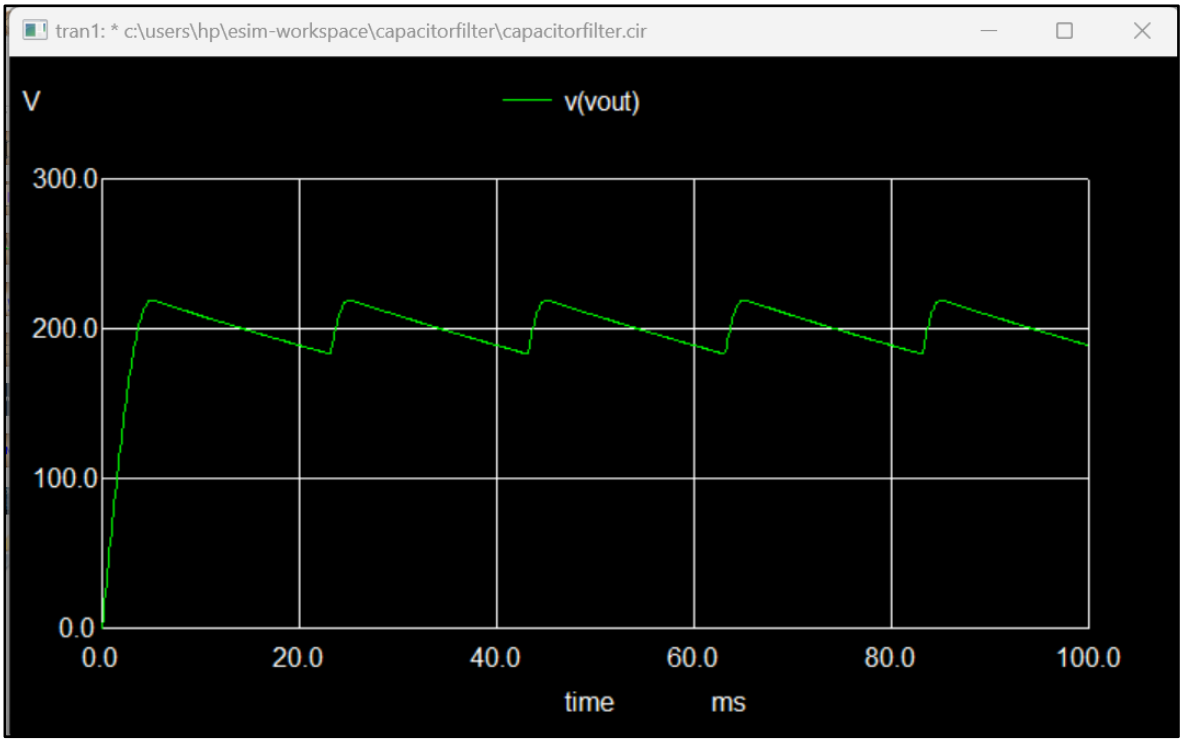

Figure 6: Ngspice Output Voltage Plot

2. Python Plots:

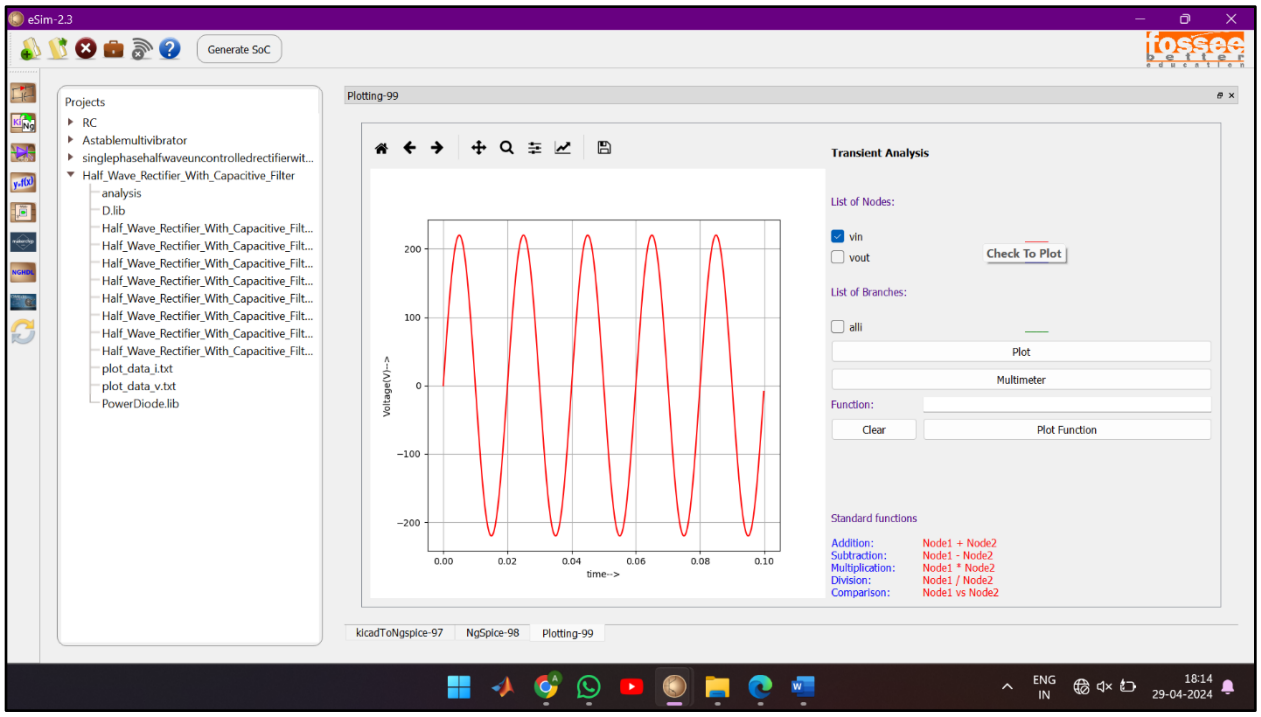

Figure 7: Python Plot Input

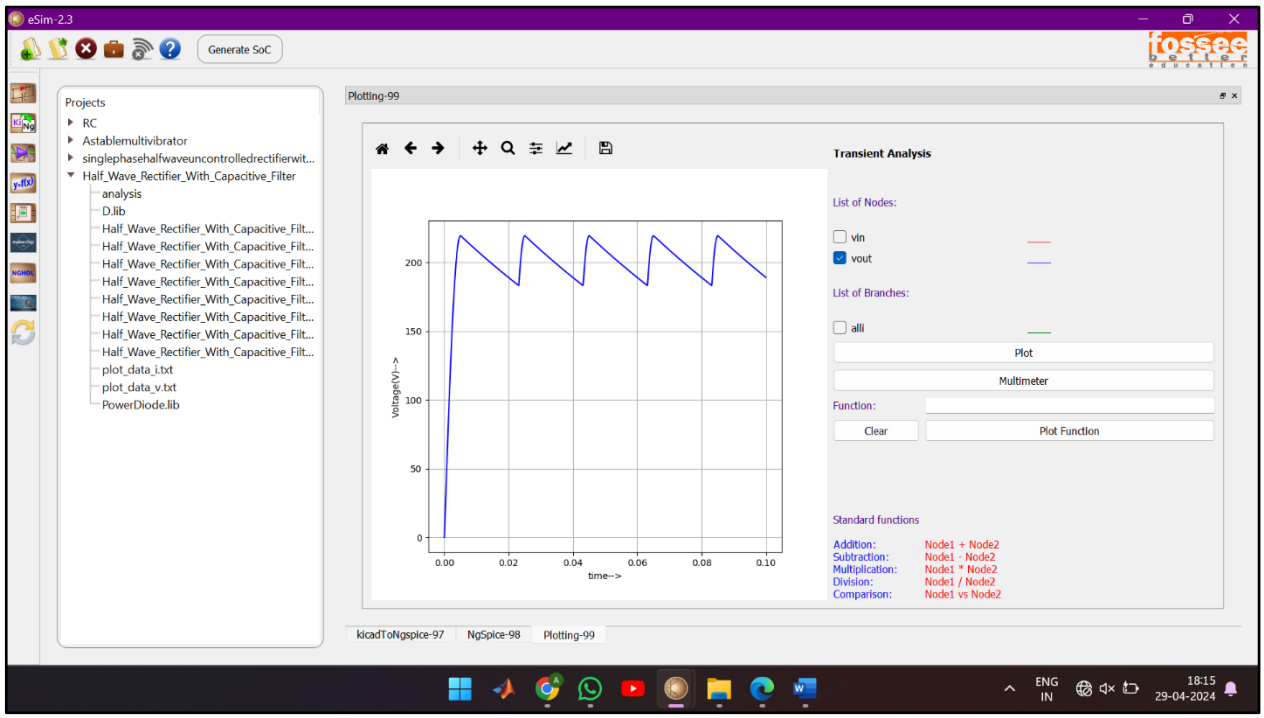

Figure 8: Python Plot Output Voltage

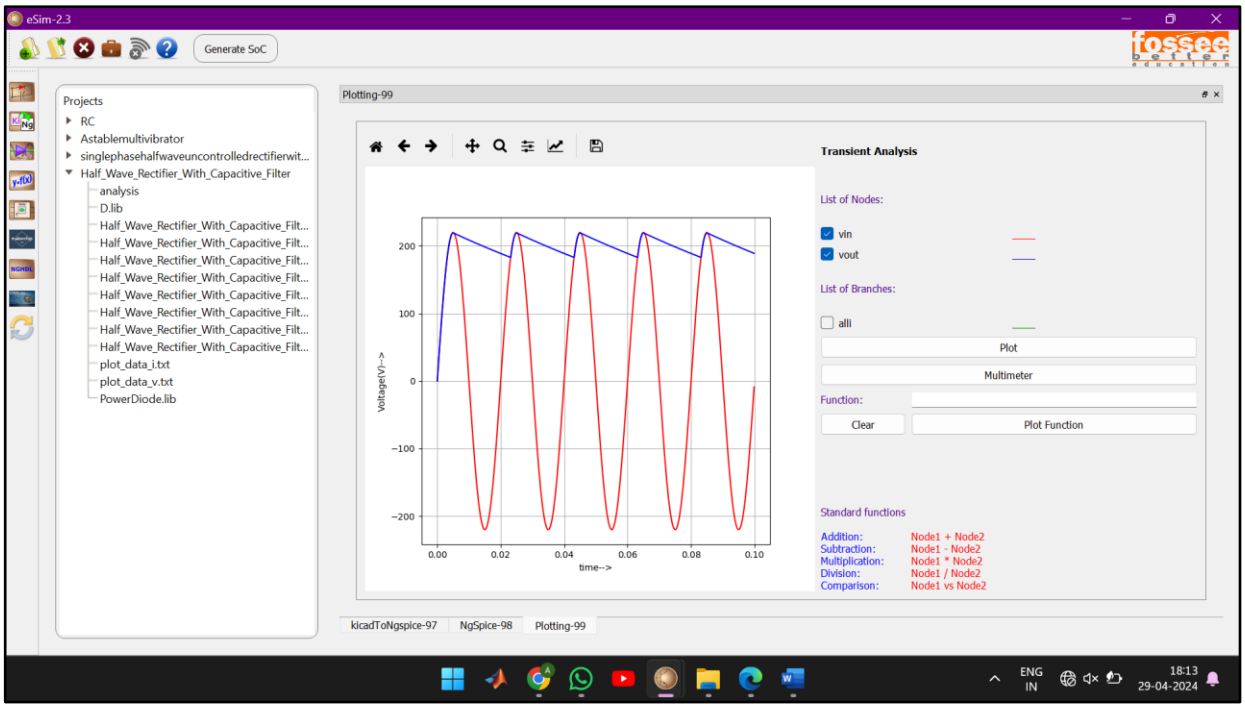

Figure 9: Combine Python Plot of Input & Output

Conclusion:

The half-wave rectifier coupled with a capacitor filter transforms AC voltage to DC voltage by allowing current flow only during the positive half cycle of the sinusoidal waveform. This configuration results in pulsating DC output, which is then smoothed using a filter to achieve steady-state DC. This process ensures a more stable and usable voltage output for various applications.

References:

1. https://www.elprocus.com/half-wave-and-full-wave-rectifier-with-capacitor-filter/

2. https://electric-shocks.com/half-wave-rectifier-with-capacitor-in-filter-and-ripple-factor-calculation/

3. Electronic Devices and Circuits/Author: David A. Bell/Publisher: Oxford University Press/page no. 45,46
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