POE2025 Week 12 Step Up Converter Hand in 7

The Aim: We get to know the basic operation and signals in the Step-Up converter based on a simulation.
The Theory: We can test the theory for the ideal vs the non-ideal for the Step-Up converter.

Hint to exercise:
Vout as function of the duty circle D,
Inductor (minimum and maximum currents and inductor size),
Load resistor size (min, max)
and filter capacitor size in relationship to the Vout ripple size (ΔVout/Vout) and switch frequency.

The Step-Up converter.

Download the Step-Up Converter file (LT Spice) from Blackboard: POE2025week12StepUp_new.asc

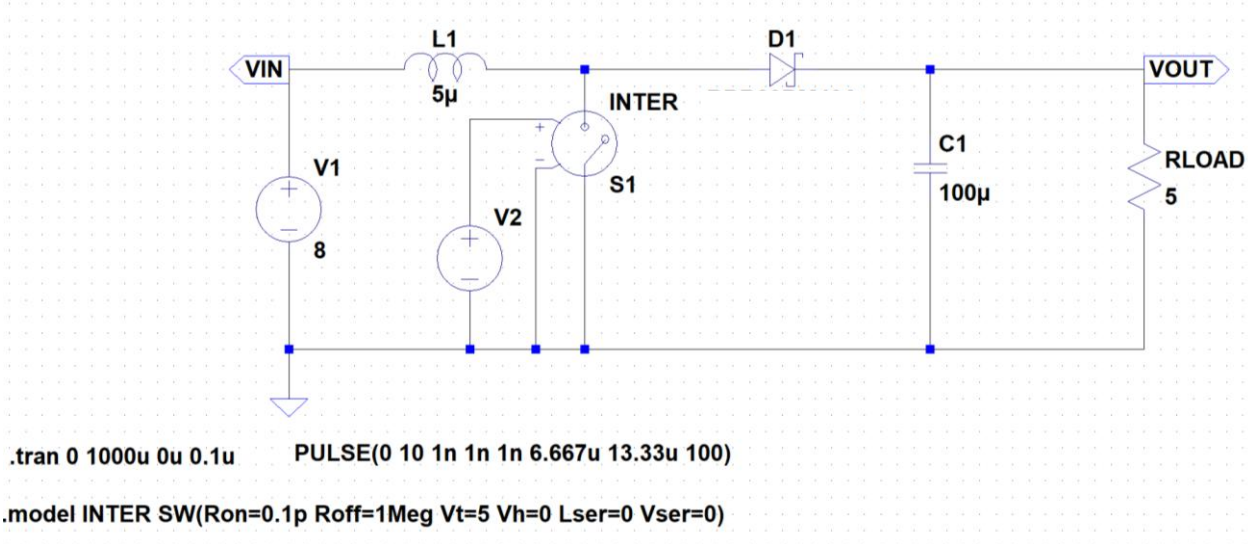

Figure 1: The Step-Up converter setup

1. Simulate and document for the Step-up converter the current thru all the components at steady-state for duty-cycle D=50% by some screendumps – try to make the screen dumps line up in time if possible, so that you can follow what goes on in the circuit. Use the current probe.

2. Simulate and plot the output voltage as function of the duty-cycle D for RLOAD = 5Ω (see and fill table below, then plot the values of Vout(D) graph; You can use a tool like Excel or similar. Then compare it to the theoretical value and comment (use % deviation). The values must be STEADY STATE values.

Dutycycle D	Simulated. Vout @RLOAD = 5Ω	Calculated by Theory Vout=Vin*1/(1-D)	Comparison & comments
0.1			
0.2			
0.3			
0.4			
0.5			
0.6			
0.7			
0.8			

Table 2: Values for the Step-Up converter

3. Harmonics in the output voltage of the Step-Up converter:
For the simulation, please use the FFT **(NOTE: the transient data logging must first start when the Step up converter is in STEADY STATE – so don't take the time that include the transient state)**, and simulate the amount of harmonic frequencies in Vout. Take the screen shot of the Harmonics in Vout at D= 0.5 and RLOAD = 5Ohm. Investigate how the filter capacitor affects the harmonics, by increasing/decreasing its value 100%.

Summary of deliveries for the Step-Up Converter:

1. Screen dump of the current in the components and visualized. Settings: D = 0.5, RLOAD = 5 Ohm, V2 frequency= 75 kHz.
2. A filled in Table 2, with your simulated and calculated values.
3. A graphical plot of your Table 2: Vout as a function of duty cycle D. The simulated and calculated values are drawn in the same graph, and the deviation is commented. You could use Excel to make the plot. Remember to name the axis. X-axis = Duty cycle, D and Y-axis = Vout. Add your comments to the simulated vs theory values – where do you think the deviations come from?
4. Screen dump of the FFT window, so that we can see the harmonics in Vout. The screen dump is made at D = 0.5 and RLOAD = 5 Ohm.
5. Your small theory reflection about the Step-Up converter (a single A4 page of text/sketches that are your own words/drawings) – you can use the hints to explore the circuit. I'm not interested in copy-paste from the internet or books, but how you perceive/understand it.

If you have experimented with the component values effect on the output voltage ripple – which components affect the ripple the most?