Lab 1: Power Management

ESE350: Embedded Systems & Microcontroller Laboratory
University of Pennsylvania

In this document, you'll fill out your responses to the questions listed in the [Lab 1 Manual]. Please fill out your name and link your Github repository below to begin. Be sure that your code on the repo is up-to-date before submission!

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GitHub Repository: https://github.com/jjfrank0324/ESE519-Lab1

1. Using the kirchoff's law, we can derive the following:

$$\frac{V_1 - V_{node1}}{R1} = \frac{V_{node1}}{R2}$$

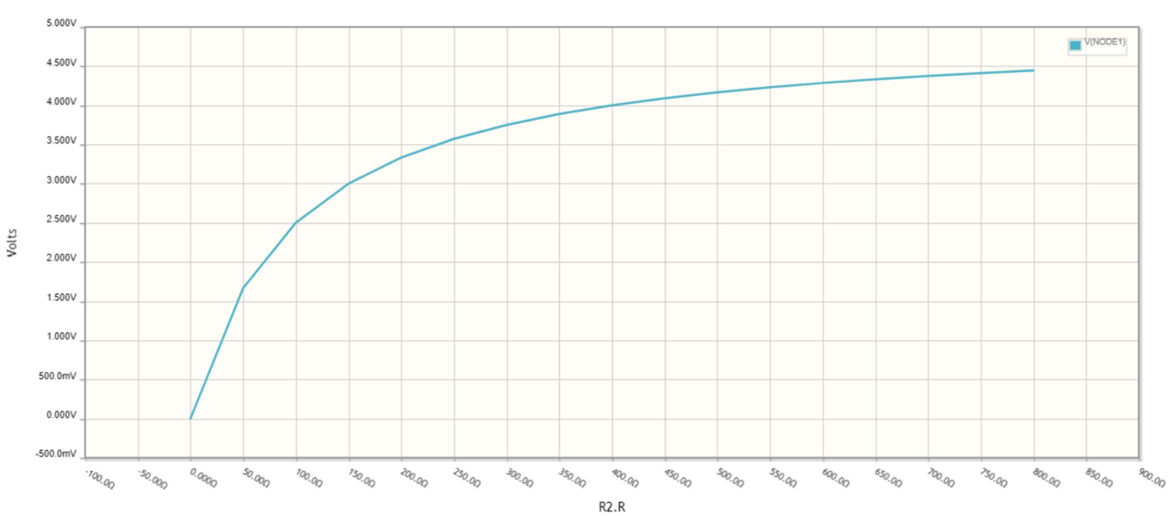
By simplify the equation, we can get:

$$V_{node1} = V_1 * \frac{R2}{R1 + R2} = 5V * \frac{100}{200} = 2.5V$$

2. Using the same formula, we can get the new voltage at V1 is the following:

$$V_{node1} = V_1 * \frac{R1}{R1 + R2} = 5V * \frac{850}{100 + 850} = 4.474V$$

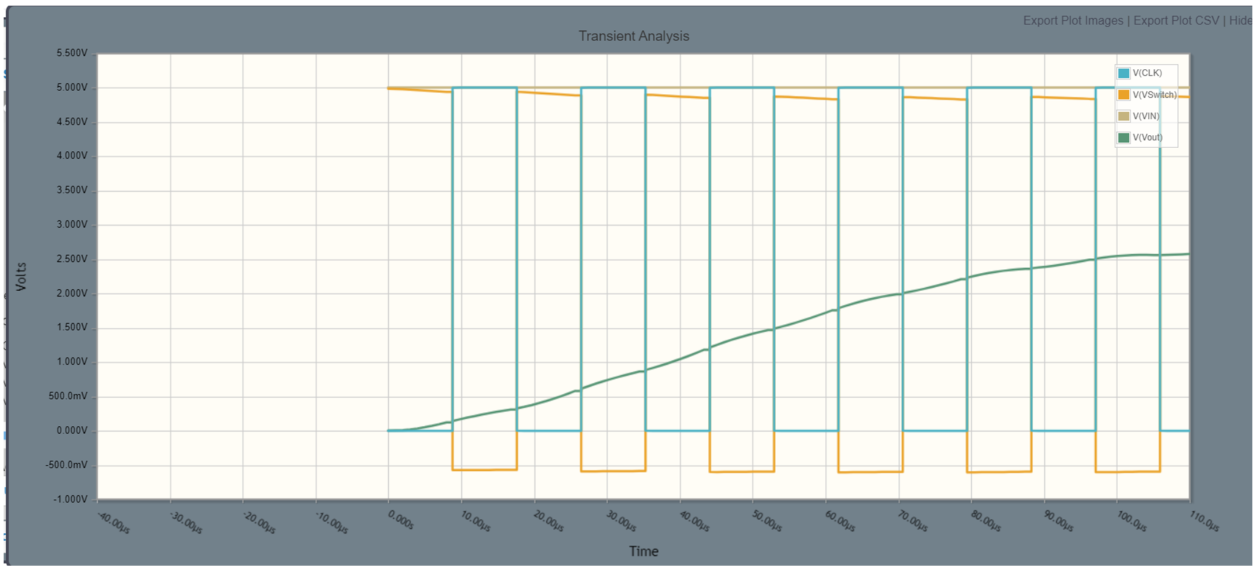
3. Screenshot:



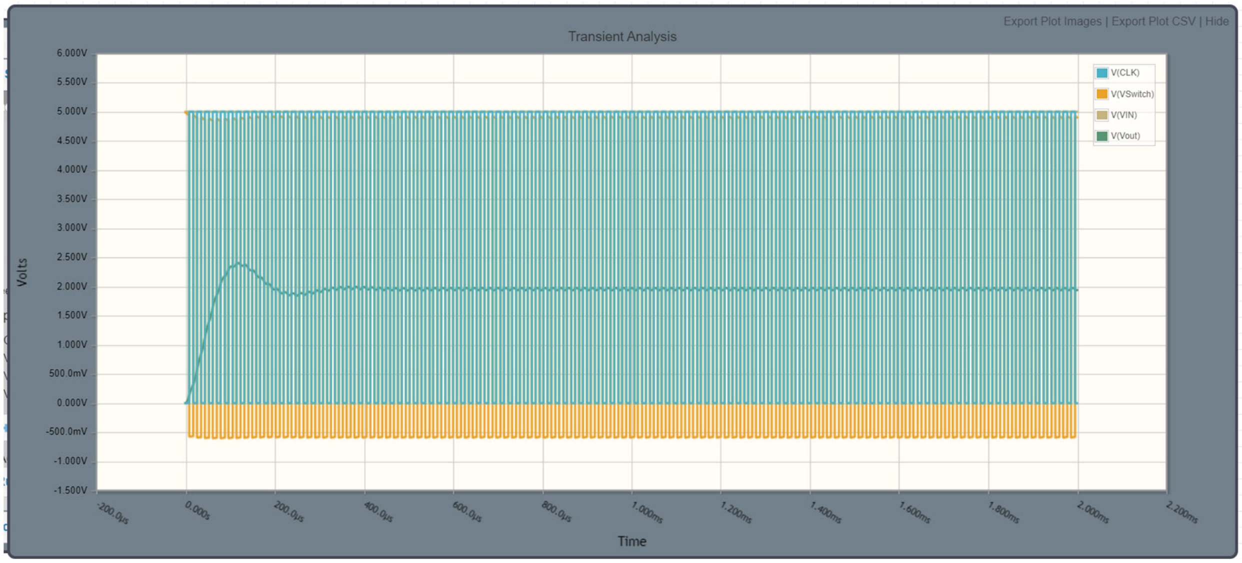
Explanation:

Yes, this is the expected behavior. According to the simple voltage divider rule, as the resistance of R2 get larger, the voltage it gain will also become larger. Thus, is the end (the upper right corner), R2 will eat up most of the voltage on the circuit.

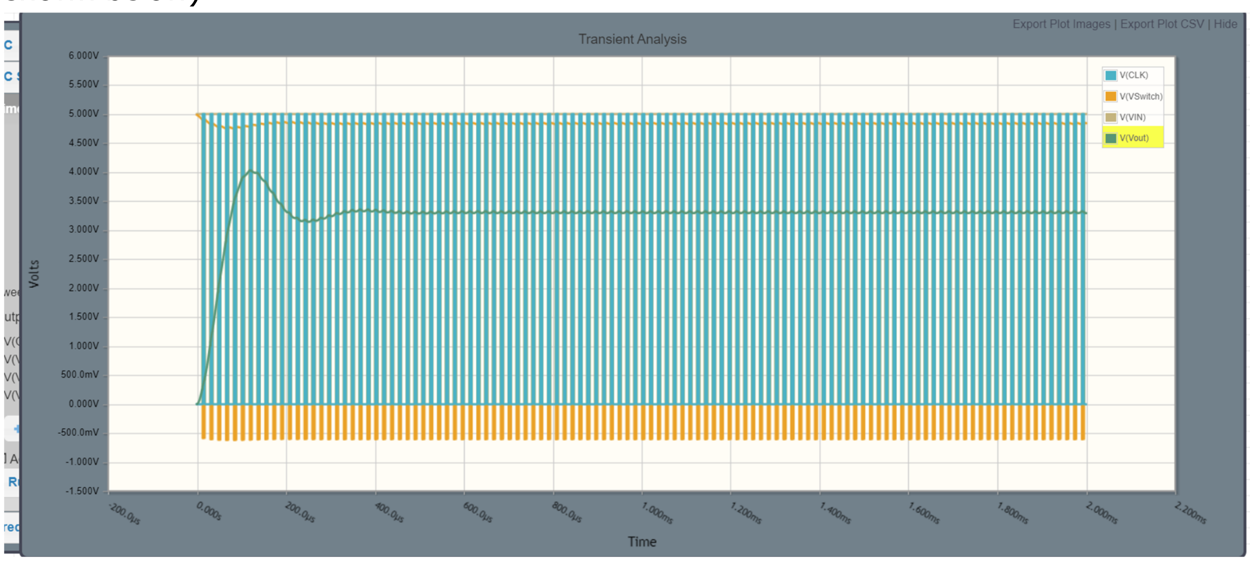
4.
   a) Human Interraction device: use it as some sort of input(Joystick/thumbstick)
   b) Volume Control for audio devices
   c) Smart home: change LED color
5. Duty cycle represent the percentage of time when the CLK singal is high. According to the plot, when the clock is high, the MOSFET will be off. In the contrast, when the clock is low, the MOSFET will be on.



6. When the Duty Cycle is around 0.52, the output voltage will be around 2V(As shown below).



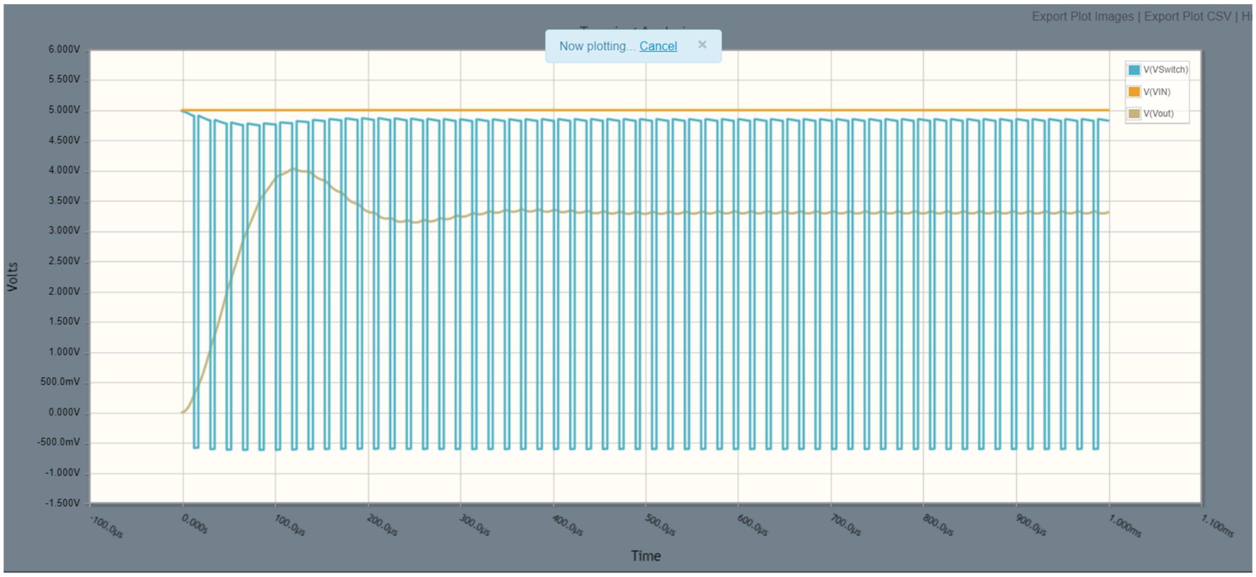
When the Duty Cycle is around 0.265, the output voltage will be around 3.3V (As shown below).



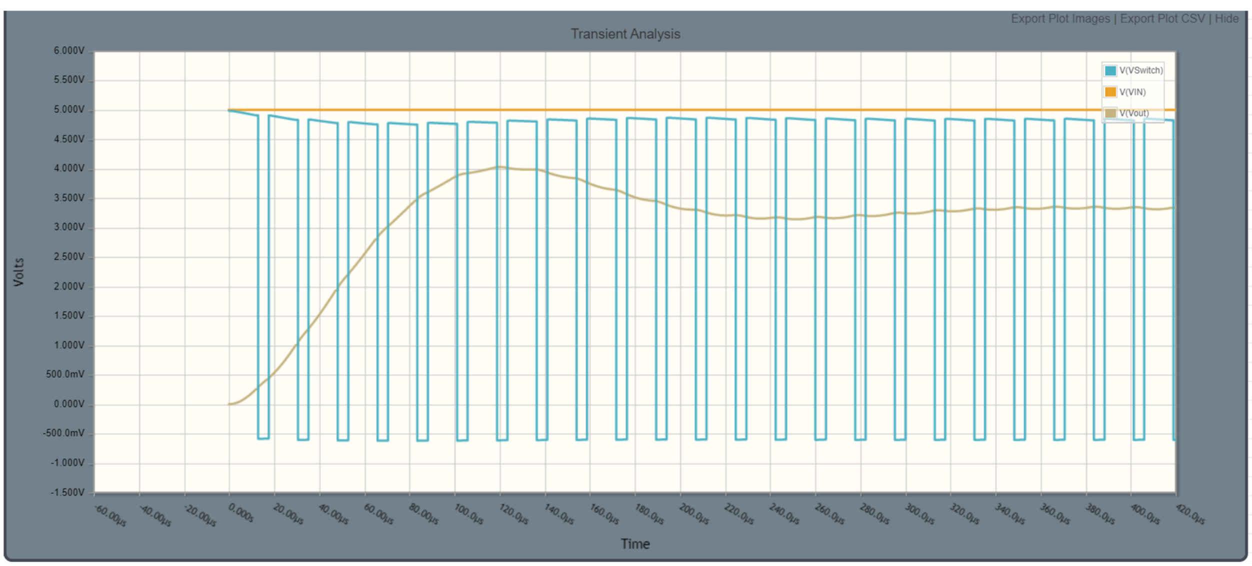
Explanation:

Yes, the value makes sense. When the Duty cycle is small, the MOSFET will be on for more time. Thus, the RC circuit will be charge up and oscillate a little bit longer. Thus, the output voltage will be higher. Furthermore, since we are using the real-component data in the schematic, the simulation result will be slightly different than the ideal result.

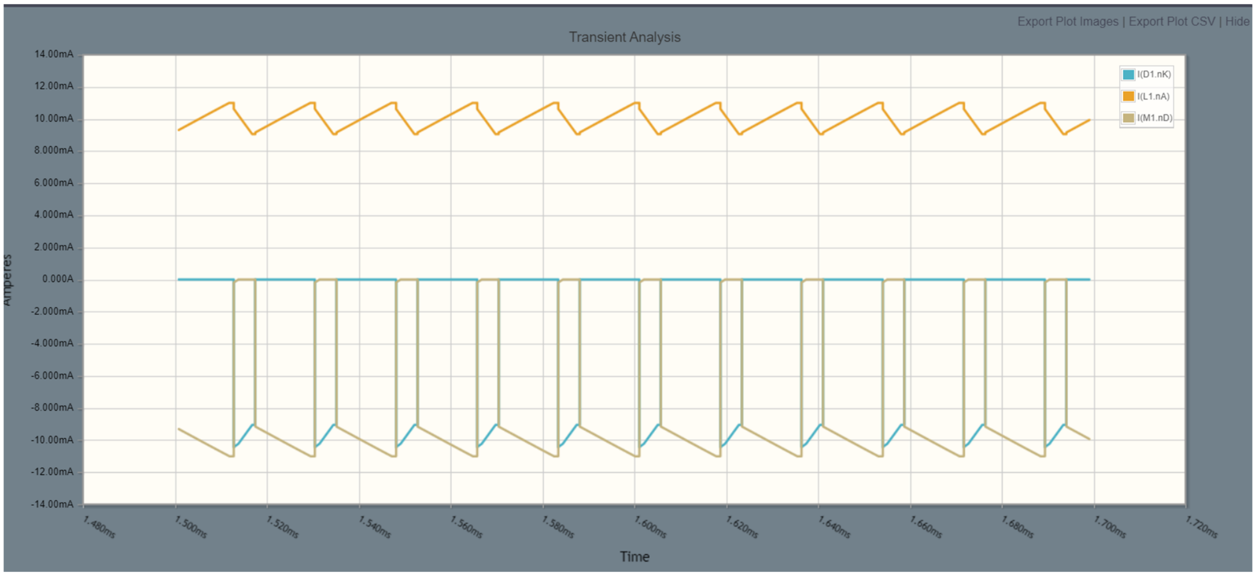
7. The generate plot is attached below:



8. Since the circuit basically is a RC circuit, this basically means it oscillation would occur. Thus, they must be some sort of dip inside the circuit, and the output cannot be a perfect straight line. This is due to the characteristic inductor and capacitor, and how we specifically designed it in our Buck circuit.

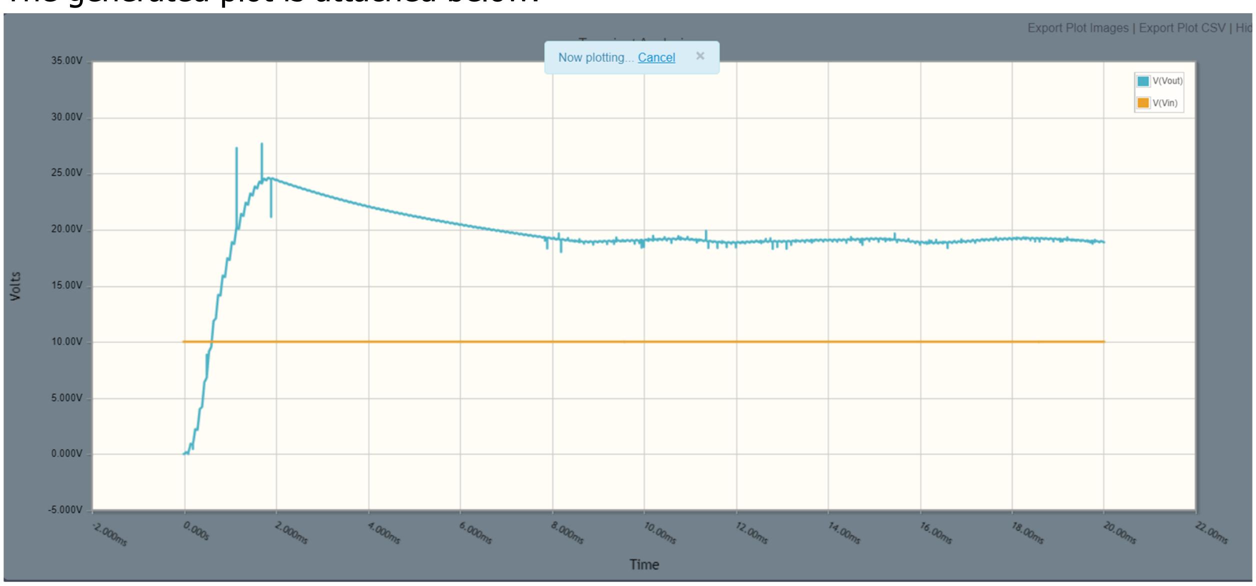


9. The generated plot is attached below:



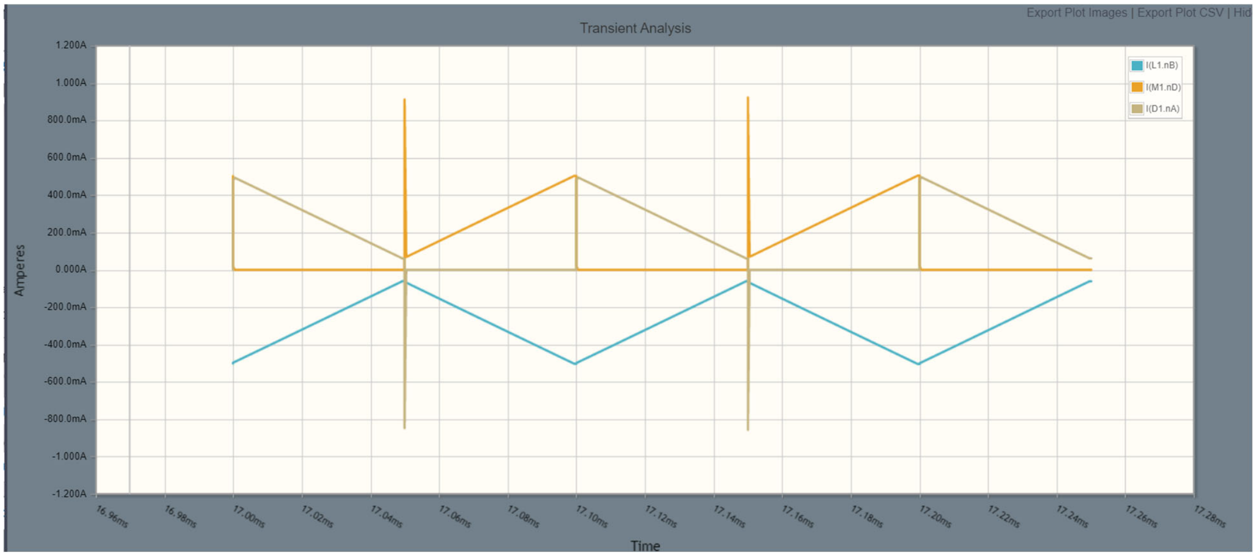
10.
The sum of these three currents will always be zero. Since the current are sample from the same netlist, the current flow from one node will always flow to the other nodes (won't disappear) according KCL. Thus, this is the expected behavior, and the result also makes sense.

11.
The generated plot is attached below:



12. Somewhat, yes. The circuit successfully boost up the voltage. However, its final value is not consistent with the theoretical calculation(may cause by circuit lab using real components values).

13. Because for this specific system, the time constant is slightly different from the time constant of the previous system. Furthermore, we can also see that the such system has larger voltage overshoot. Thus, it may take longer to recover it back to the normal states.
14. The generated plot is attached below:



15. The sum of these three currents will always be zero. Since the current are sample from the same netlist, the current flow from one node will always flow to the other nodes (won't disappear) according KCL. Thus, this is the expected behavior, and the result also makes sense.

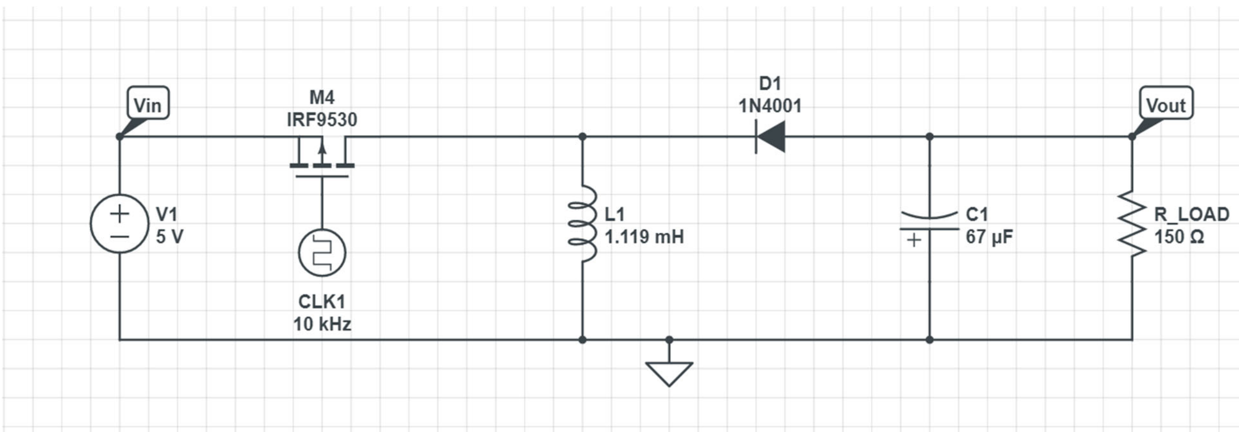
16.

Jack	USB	Power Source?	NODE1	NODE2	NODE3
0V	5V	USB	-928.8uV	4.99V	3.3V
10V	0V	JACK	5.001V	5V	3.3V
10V	5V	JACK	5.001V	5V	3.3V
3V	5V	USB	-928.8uV	4.99V	3.3V

17. When we implement a voltage divider on the barrel jack side, the circuit itself will have priority of choosing the USB as the voltage source (like what is shown inside the table above). Under such configuration, the voltage goes in the positive side of the op-amp will always be less than the voltage coming out of the barrel jack. Thus, the barrel jack won't be the priority voltage source over here. The circuit will choose to use the barrel jack only when the USB voltage is significantly lower than the voltage from the barrel jack.

18.

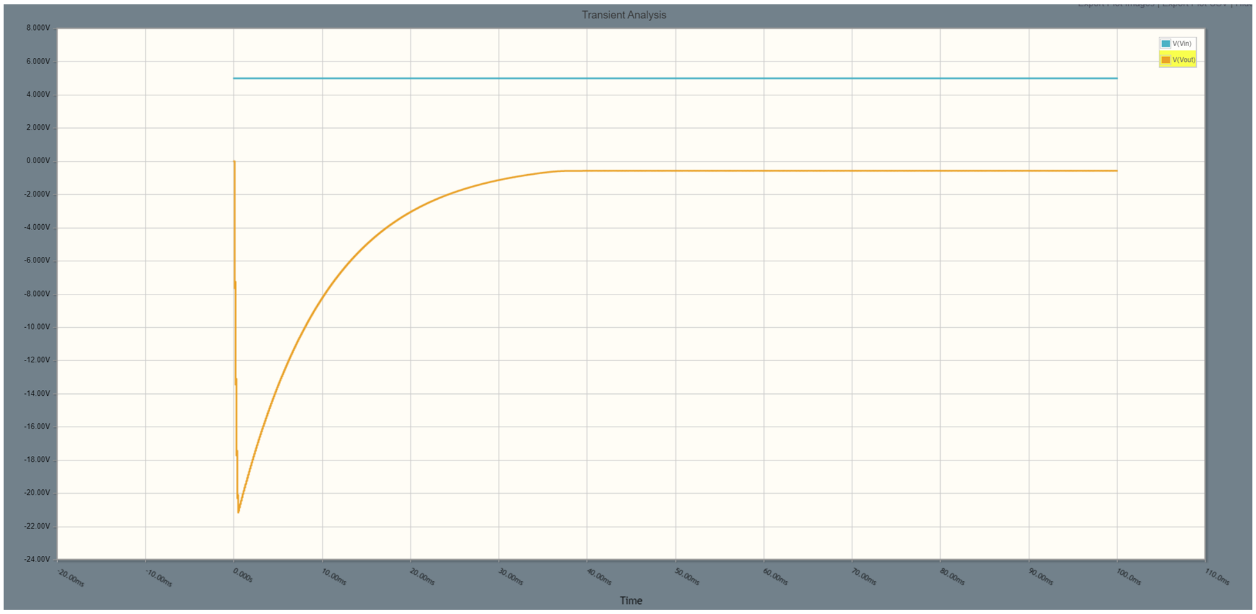
The buck-boost circuit I constructed is shown below:



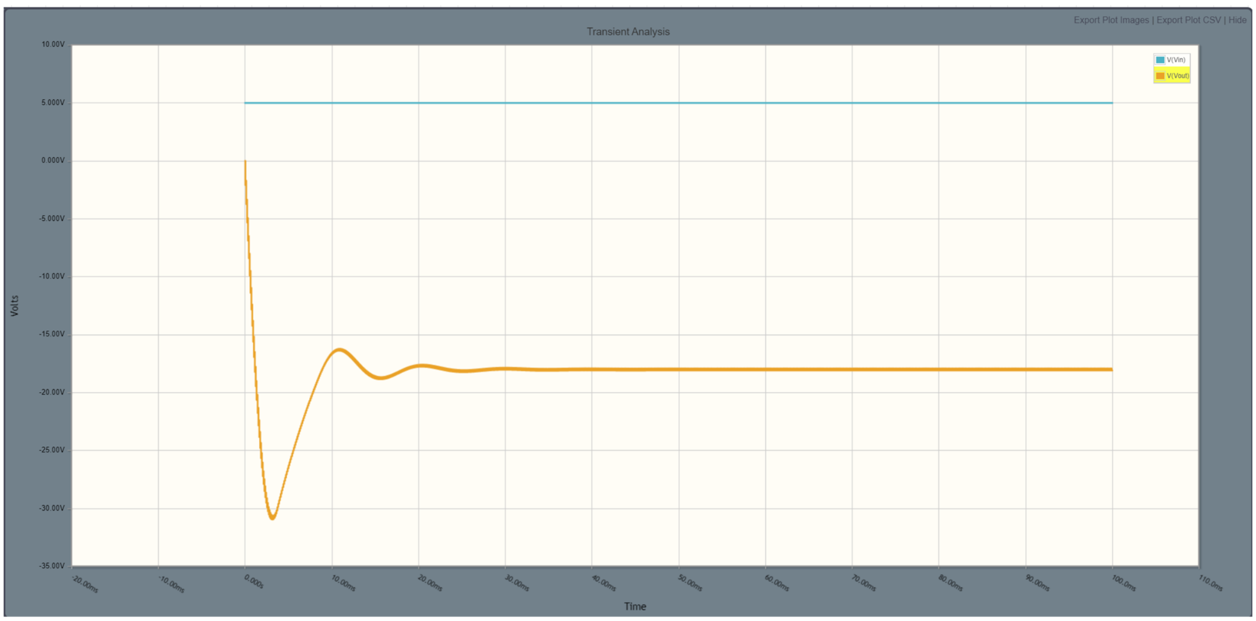
The link of the schematic I constructed is the following:
https://www.circuitlab.com/circuit/s9vy728kbbek/buck_bosst/

(Circuit construction reference user: online user id-> yunyouxun)

19. Buck scenario: voltage goes from 5V to 560mV



20. Boost scenario: Voltage goes from 5V to 18V



21. In general both BJTs and MOSFETs can be used for controlling the circuit and make it behave in the desired way. However, the physical properties of BJTs and MOSFETs are dramatically different. BJTs is a bipolar junction device, which is current driven. MOSFETs are Filed effect transistor, which are voltage driven. Because of this, BJTs is not usually suitable for devices power consumption devices, since the leak current may consume excessive power, and possibly contribute to power waste. Thus, in general, BJTs is more suitable low power consumption devices, and MOSFETs is more suitable for large power consumption devices.