Lab 1: Power Management & Bootloading

ESE519 - Embedded Systems - Fall 2020

Due: Friday, September 15, 2020 23:59PM EDT

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: tolerner31/lab1-tolerner

1. I used Ohms law to dirive the Voltage divider equation and Professor Luong said this was ok.

$$V1 = I \times R_{total}$$

$$R_{total} = R1 + R2$$

$$I = \frac{V1}{R1 + R2}$$

$$V_{node1} = I \times R2$$

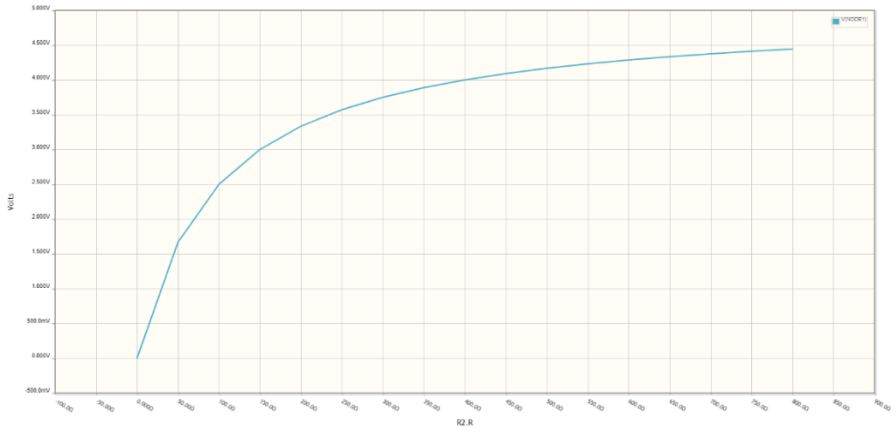
$$V_{node1} = \frac{V1 \times R2}{R1 + R2}$$

$$V_{node1} = \frac{5 \times 100}{100 + 100} = 2.5V$$

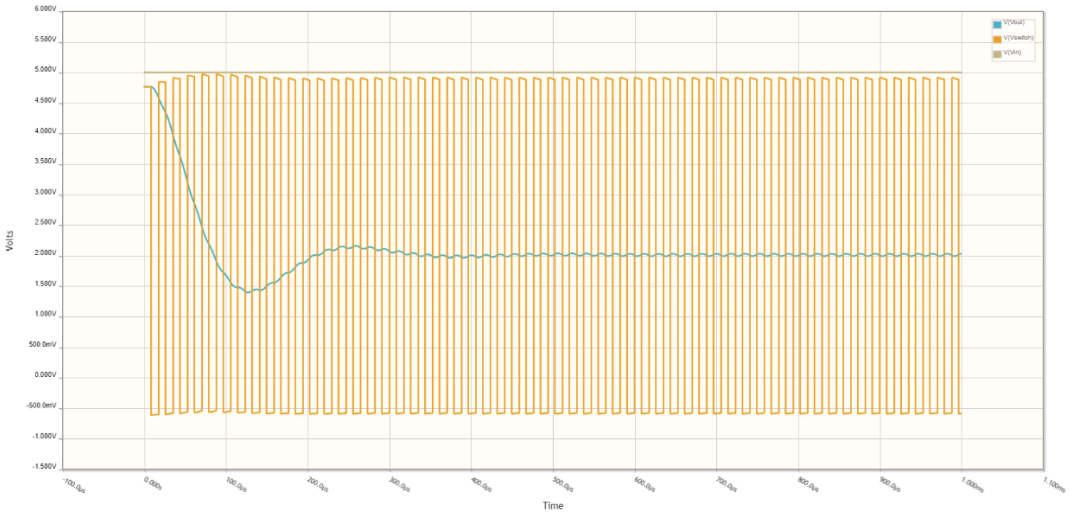
2. Replace R2 with 850 on the top and bottom

$$V_{node1} = \frac{5 \times 850}{100 + 850} = 4.47V$$

3.

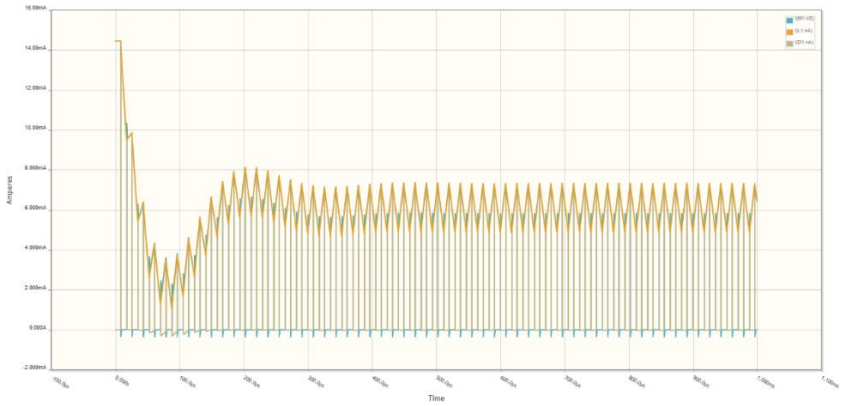


This is what I expect since there is no voltage drop when there is no resistance and as the resistance increases it approaches 5V since R1 stays a consistent 100ohms.

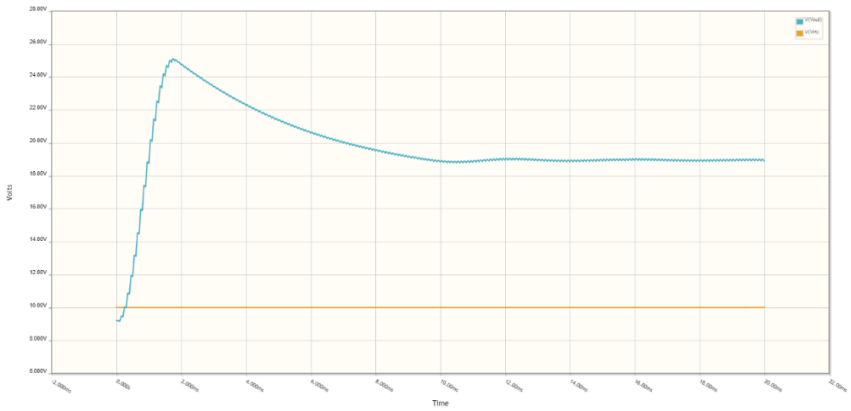
4.
    a. Scaling down a battery voltage so it can be measured by an ADC that has a max voltage lower than the battery voltage
    b. Adjusting the output voltage of a linear regulator that has a variable output voltage
    c. A potentiometer is a voltage divider that can have the ratio of R1 and R2 changed. This can be used as an accelerator pedal in a car.
5. Duty Cycle Represents time High in CLK1
6. For Vout = 3.3V Duty Cycle needs to be 0.27. for Vout = 2V Duty Cycle needs to be 0.53. This makes sense because this circuit inverts the Duty cycle from Vclk to Vswitch so when Vclk has a higher duty cycle that means voltage is being fed to L1 for a shorter amount of time and this would reduce the overall voltage.
7. 

8. The dip in output voltage around 100us is caused by the LC filter charging up. This then starts to equalize but in the steady state there is still noise caused by the switching on and off of the transistor. When the transistor lets power through it charges up the inductor and when it turns off the inductor discharges that power. A more beefy filter would do a better job of reducing this steady state noise.

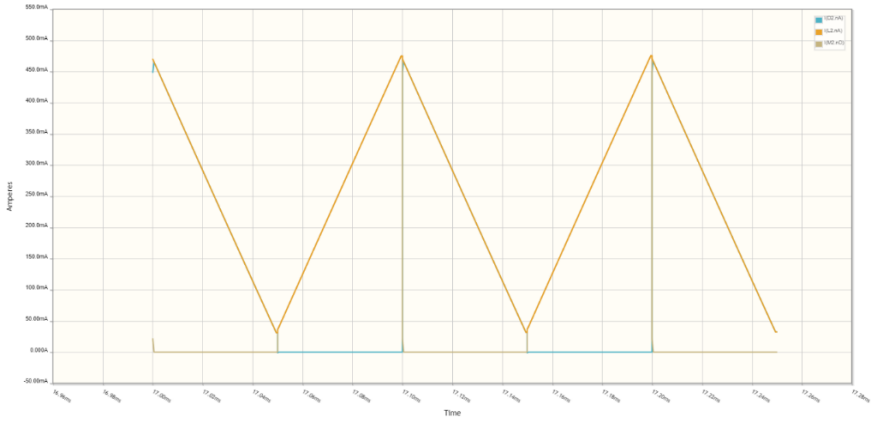
9.



10. When the transistor is on it is feeding current to the inductor and when the transistor is off the diode is feeding current to the inductor. This makes sense because the current going into the Vswitch node is equal to the current going out of the Vswitch node. There are some transient spikes but those are due to switching and can be ignored.
11.



12. This makes sense because approximately doubling the voltage seems like it would have a lot of uses and it would be reasonable to expect people would make designs to do this
13. Having the diode and transistor between the inductor and capacitor separates them from interacting with each other as much
14.



15. This does make sense because the inductor current is equal to the diode current plus the transistor current (Current into the node equals current leaving the node)
16.

Jack	USB	Power Source?	Node1	Node2	Node3
0V	5V	USB	-928.8uV	4.999V	3.3V
10V	0V	Barrel Jack	5.001V	5V	3.3V
10V	5V	Barrel Jack	5.001V	5V	3.3V
5V	5V	USB	4.315V	4.315V	3.3V

17. The inverting input of the op amp is connected to the 3.3V output and since both inputs of the op amp have the same voltage that would mean the barrel jack would be connected to 3.3V. Bad things happen when you connect 10V directly to 3.3V. Also an ideal op amp does not allow current into the inputs so it would need to find a return path which would probably be through components in a way that they are not meant to handle.
18. Optiboot is a bootloader program. This is a pre-loaded program in the microprocessor that runs on startup and configures it before the main program starts running. The bootloader also allows you to install new software or firmware without using an external programmer.
19.