ENGR 321
Design Project – Due Dec. 6

For this project, your task is to design the converter and control circuitry required to power a load.

Your car battery is at 12.6 volts. Inside your car, you have a USB port supplying 5V to charge your phone. Maximum voltage ripple allowed is 0.1%. When plugged in, your phone consumes between 0.2A and 2A. Your converter must operate in CCM over this range of output current.

Task 1. [15 points] Design the converter.

Find/specify:

- Switching frequency
- Theoretical duty cycle
- Capacitor size and max V
- Inductor size and max I. You can use any value of inductor ripple from 20%-40%.
- Diode max I and max blocking V
- Mosfet max I and max blocking V

Task 2. [40 points] Build and simulate a real converter.

Build your converter in Multisim. The input to the switch should be the built-in PWM generator (called Clock Voltage). For the Mosfet and the diode, use the 2N7000G and 1N4148 that Multisim provides, not a generic one. Compare your simulated output voltage, voltage ripple, inductor current, and current ripple values to your theoretical values.

Derive the transfer function for a buck converter, but for a realistic diode and Mosfet. The diode should have a voltage drop of V_d while it is conducting. The Mosfet will have a resistance of R_{ds}(on) when conducting. Using your realistic transfer function, calculate what your V_{out} should be. How does it compare to your simulated V_{out} now?

Task 3. [15 points] Design the control circuitry.

Design the control circuitry such that the output voltage error (the average value, not the ripple) is no more than 0.05V. Find the values of resistors and capacitors necessary for the 555 timer, the integrator, and the comparator.

Task 4. [30 points] Build and simulate the controller.

Add your controller to Multisim (take out the built-in PWM generator you had before, since you have made your own). What is your output voltage? How does it compare to what you expected?

Notes.

Show your work. You may handwrite your project, but please write (or rewrite) neatly.